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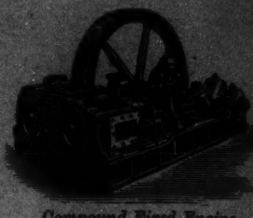

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XV.—No. 360.

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(Reported specially for the "Electrical Review.")

IN the lecture hall of the Philadelphia Electrical Exhibition on September 8th, the opening meeting of the National Conference of Electricians was held.

Prof. SIMON NEWCOMB called the meeting to order, and commenced the proceedings by saying:—

The United States Electrical Commission has charged me with the honourable duty of calling this conference to order and making a brief statement of its objects. I have had no time to prepare any remarks whatever, and will merely do what is required of me—state how it is that we come to be called together.

The enormous advance made in electricity within the past few years has resulted, as you know, in several electrical exhibitions in other countries. The object of these exhibitions is to bring together the various improvements which are made by inventors in the applications of electricity. The possibility of these improvements, I may say, parenthetically, offers a very remarkable example of the practical value of pure mathematics. It is only in consequence of the reduction of electrical phenomena to mathematical laws, and their expression in such technicalities as ohms, volts and ampères, that it has been possible to make the great improvements with which you are so familiar in the practical applications of electricity.

You are brought here together as practical electricians interested in the improvements made on this subject, and each of you desirous to learn from others.

We are here, I say, as practical electricians, desirous to learn from each other, and exchange views on the list of subjects which has been made out by the United States Commission, with the best light it could get from the practical men with whom it consulted. We hope to have your views on all these points, and to have your support in any public measures you may deem advantageous to present to the Government, with the view of getting support for them in the future.

With this statement of the objects of the present commission, gentlemen, I have the honour to introduce to you the President of the Conference, Professor Henry A. Rowland, of Johns Hopkins University, Baltimore.

ADDRESS OF PROFESSOR ROWLAND.

To the student of science who has a disposition to look into the pages of history, no life has greater interest than that of Archimedes, and yet there are few men about whom so little is known. Living more than 2,000 years ago, the accounts of him which have come to us are little short of fabulous, and yet they are of such a nature that we can say without any doubt that he was a genius such as the world has seldom seen. To him we owe some of the fundamental facts of mechanics, such as the principle of the lever and the pulley, and the fact that a body immersed in a liquid loses in weight as much as an equal volume of liquid weighs. But his principal work was in geometry; and as to the quality of the individual, the impression which his writings give us is that of a power which has never been surpassed. No one has a right to say that Newton himself, in the place of Archimedes, could have done more.

Plutarch says of him "Archimedes possessed so high a spirit, so profound a soul, and such treasures of scientific knowledge, that, though the inventions" (referring to his engines of warfare) "had now obtained for him the renown of more than human sagacity, he yet would not deign to leave behind him any commentary or writing on such subjects; but, repudiating as sordid and ignoble the whole trade of engineering, and every sort of art that lends itself to mere use and profit, he placed his whole affection and ambition in those purer speculations where there can be no reference to the vulgar needs of life; studies, the superiority of which to all others is unquestioned, and in which the only doubt can be, whether the beauty and grandeur of the subjects examined, or the precision and cogency of the methods and the means of proof, most deserve our admiration."

Here then, at the dawn of science, the question of the relative value of pure and applied science had been brought up. The geometrical and mechanical truths which Archimedes discovered are to-day almost the axioms of the mathematician and the worker in physical science, and the ratio of the circumference of a circle to its radius is to-day the most important of our physical constants.

He preferred his geometrical labours because of a subtle quality of his mind, an instinct towards that which was highest and noblest and a faith that the pursuit of what is noble is the surest road to the final happiness of the individual and of the world. Our highest moral qualities are of this nature, and we despise as the lowest of the low one who is honest because "honesty is the best policy," but esteem him whose instincts lead him to honesty whatever the consequences.

So we reverence the noble and lofty spirit of Archimedes, and yet we do not at the present day quite agree with his estimate of the relative value of his works. We know that the mind is hampered by many considerations connected with the body. Archimedes recognised this, and his noble spirit revolted at it. But to-day we see that no progress can come from this method of treatment; the body still remains, however much we may despise it, and the buzzing of a fly can disturb the most profound thought of the philosopher.

We now study the laws of nature and seek thus to assist our bodies in obeying the thoughts of our minds. Instead of being the slaves of nature and grovelling in the dust before her to find the food which we crave, we have now assumed the command, and find her a willing servant to those who know her language.

But here we reach the keystone of the problem. To command her we must know her language. Knowledge, then, is the price of her service, and she obeys not the ignorant or degraded, but grinds them into dust beneath her heel.

Knowledge, then, is power, and it is more than power; it is that which the intellect most craves and is the object of many of our highest aspirations. What is the truth is the goal of intellectual mankind in all ages, and its pursuits lead not only to intellectual but also to physical satisfaction.

The pursuit of the one leads to the other, and we shall see as we proceed that the only way for the world to progress in practical science is by the cultivation of the theoretical science.

Pure science must exist before its applications, and the truths of pure science are far more reaching in their effects than any of its applications; and yet the applications of science often have a much more immediate interest for the world at large than many discoveries in pure science, which will finally revolutionise it, both physically and mentally. They both have their importance and both are at work in causing that intellectual and material progress in which the world is now pushing forward with giant steps. But there is this difference—the names of the great inventors are seen in every paper and their deeds are recounted to the rising youth of the country as examples to be followed. And yet the discoverers of the principles on which their inventions are based may have died in comparative obscurity, with poverty knocking at the door. We are in no danger of forgetting those who have been successful in those applications of science which are in daily use, and it is useless to repeat the story of the telegraph or telephone, but it will be of more interest for me to recall to your minds a few of the landmarks in our science and then to consider the present state of our science, with a possible glance into the future.

Thus we shall obtain a clearer view of how our science has been built up and of the means which are necessary for its further progress. We shall also see the relation between pure and applied science, and the relative importance of the two in the progress of the world.

The average intellect of mankind has improved, and what could only have been comprehended in past times by a few is to-day understood by the majority of educated persons. And this increase has been most apparent in the reason and moral sense of mankind, the two qualities of the mind which come most into play in the study of science.

The simple experiment of the amber by the ancients remained without investigation for 2,200 years. Why should anybody investigate this phenomenon, this feeble force, which could only attract a few particles of dust? The world could eat, drink and take its ease without doing anything in the matter, and it did so for more than 2,000 years of intellectual, moral and physical degradation. Then the awakening came, and men began to feel that they were reasoning beings. No question of gain entered into the minds of these early investigators, but they were led by that instinct toward truth which indicates the highest type of man. And yet their researches have transformed the world not only intellectually, but physically. Some would say that science had been degraded by its applications, but who, that looks over the world at the present time, can think so? There is no danger of this view becoming general; the danger is in the other direction, and that science shall be degraded in the estimate of the world by the idea that its principal use is to be applied to the common purposes of life. A thousand times no! Its use is in the intellectual training of mankind and the high and noble pleasure it gives to those who are born to understand it; to make even Newton say: "I know not what the world may think of my labours, but to myself it seems to me that I have been but as a child playing on the sea-shore—now finding some pebble rather more polished, and now some shell rather more agreeably variegated than another, while the immense ocean of truth extended itself unexplored before me."

But the great moral law of the universe here enters. If the world would only pursue those things which are high and right and noble, its reward would not be confined to the minds of men. Physical rewards await it as well, and disease, that principal cause of human misery, would almost pass away when the effect of inheritance from the present generation had passed. So the pursuit of pure science brings not only the rewards I have mentioned but the physical rewards of applied science, and the pursuit of applied science gives wealth which may be again employed to further pure science. So the two react on each other to produce that perfect whole—modern science, pure and applied.

It is to William Gilbert, an English physician, that we owe the commencement of the modern science of electricity. But how slowly did the subject advance! The difference between conductors and non-conductors was discovered by Grey. But not until 1746, 150 years after Gilbert, was the Leyden jar invented. Then the remarkable nature of the phenomenon became apparent, and the world was startled by it. To the world at large, there was now something worth looking into. But do not think that the spark from the Leyden jar is more wonderful than the gentle attraction of the amber. By no means; for, to the scientist, they are both equally remarkable and beyond our powers of explanation. Nevertheless, despicable as the means, the spark of the Leyden jar acted as a trumpet call to Europe and even to America to come to the study of the wonderful science of electricity. At no other time has there been such excitement over any electrical discovery, and electrical experiments became general.

It was only after the discovery of the Leyden jar that the idea of an electric current occurred to mankind, and this current was even transmitted to a distance by a wire and a shock given to a person across the Thames, the water forming the return circuit. And the English experimenters even went so far as to form a circuit with the two observers two miles apart, using the earth as the return circuit. Thus the fundamental fact which forms the basis of the telegraph was early observed.

But isolated facts are of little value unless connected together by something which we call a theory, and in this line we owe much to Franklin, whose letters on this subject appeared between 1747 and 1754. To him we owe the theory of positive and negative electricity, and the fact that they are always generated in equal amounts, a law whose importance can scarcely be estimated. He investigated the Leyden jar and showed that the coatings had equal positive and negative charges, and explained the fact that the jar cannot be charged when the outside coating is insulated. He invented the charge and discharge by cascade, and showed that it was the glass of the jar and not the coatings which contained the charge. He discovered the property of points in discharging an electrified body and the identity of lightning with electricity. He also made the first experiments upon atmospheric electricity.

To Canton is due the honour of giving the first experiments of induction, but Franklin is the first who gave the general law of this species of action. Truly our country and this city should honour the memory of this man.

But no science is complete unless it is quantitative as well as qualitative. It is now very nearly 100 years since Coulomb laid the foundation of electrostatics and Cavendish commenced to lay the foundation of mathematical electricity, and they were followed by Laplace, Biot, Poisson and Murphy.

The discoveries by Galvani and Volta in 1790 and 1800, and by Oersted in 1820, gave us the galvanic battery and electromagnetism, and it was not until the latter date that any useful practical application was possible. Then, so complete was the science that no factor of other than minor importance was necessary to transmit intelligence from one extremity of the earth to the other.

By the labours of the immortal Faraday, electro-magnetic induction was discovered, and the modern dynamo-electric machine became a certainty.

To his other labours, both experimental and theoretical, the modern science of electricity owes much. But it is familiar to all: the name of Faraday needs no eulogy from me, for it stands where it can never be hidden, and the spark which Faraday first kindled now dazzles us at every street corner. No wealth came to him, although he had only to hold out his hand for it. But the holding out of one's hand takes time, which Faraday could not spare from his labours, and so the wealth which was rightly his went to others. Who will follow in his footsteps and live such a life that the thought of it almost fills one with reverence? It is not only his intellect which we admire, it is his moral qualities which fill us with awe, his noble and unselfish spirit.

The name of Faraday brings us down to modern times, whose history it is unnecessary to repeat in detail, especially as there are some now present who have contributed largely to bring the science to its present perfection.

One of the principal features which we remark in our modern science of electricity is the perfection of our means of measuring both electrical and magnetic quantities. In this connection the great names of Gauss and Weber appear, the fathers of the modern absolute system of electrical and magnetic measurement, and that of Sir William Thomson, in no degree less distinguished. On the laws of electric attraction we base our electrostatic system of measurement; and on the magnetic action of the current, the great discovery of Oersted, we base our electro-magnetic system, and we connect these two systems by that great physical constant, the ratio of electro-magnetic to the electrostatic system of units.

What can be simpler in theory than the electrostatic system, based as it is on the law that electric attraction varies inversely as the square of the distance? We only have to know how the electricity is distributed and its attraction is known. Hence we must select the simplest possible case, such as two parallel discs, and to render the problem calculable, we add a guard ring to the movable disc. We then have the absolute electrometer of Thomson. This gives us a measure of the electric potential. Knowing the capacity and difference of potential of the surface of a condenser, we know its charge. But all these quantities, the calculation of the electrometer and the capacity of the condenser, depend upon the mathematical theory of electric distribution. Are we able to calculate the capacity of condensers of all forms? I am sorry to say we are not. The modern method of treatment is due to James Green, an English investigator, whose name should be held in honour by all electricians. But this method is what is called an inverse one. It is not a method by which we can calculate the distribution on any body at random, but the shape of the body and the electrical distribution on it are both found at once by a species, as it were, of exploration and discovery. So that we cannot make our electrometers and condensers of any shape and then calculate them, but we are forced to make them of some simple geometrical form whose solution is known. We fit our apparatus to the mathematics rather than the mathematics to the apparatus.

But when we have satisfied all the conditions we measure out our static charges as easily as a quantity of matter. The manufacturer sells the oxygen and hydrogen in iron cylinders, and determines the amount by the product of the capacity of the cylinders by the pressure. Were there any buyers of electricity we might sell them a Leyden jar full, and determine the amount by the product of the capacity of the jar by the electric potential. According to this analogy, then, the electricity is similar to matter and the potential to fluid pressure, while the word capacity has a similar meaning in both.

In the electro-magnetic method of electrical measurement we make use of the magnetic action of the current, either on a neighbouring magnet or another current or portion of the same current. The laws of the action of a current on a magnet was discovered by Biot and Savart, and of two currents on each other by Ampère, and the results applied to practical measurement to-day give us galvanometers of all kinds and the electro-dynamometers of Weber. By the galvanometer we can measure the quantity of electricity passing at any moment, but by the electro-dynamometer we measure the integral square of the circuit, a quantity on which the heating of the circuit and the energy expended depends.

Thus the electro-dynamometer measures the energy from an alternating current dynamo-electric machine as easily as from one giving a continuous circuit; but to know this energy we must know something else besides the integral square of the current, and this is either the resistance of the circuit or the electromotive force. But the measurement of electromotive force depends on a resistance. The question then comes up as to what unit of resistance is the proper one. Here we have to refer to the mathematical theory of the subject, and the great law of the conservation of energy tells us that what is known as the absolute unit of electrical resistance is the proper one for use in this case. Hence the great practical use of determining this unit. The experiments of Kirchoff, Weber, Kohlrausch, and the British Association, found a value from one to three per cent. too large.

Many years ago I myself experimented on the subject and obtained a result about 4 per cent. too high. Recently Lord Rayleigh has taken up the matter, and made a series of experiments of unparalleled accuracy in this line. The International Commission, determined on by the Electrical Congress in Paris, in 1881, met in April of this year at Paris, and has now given us a legal ohm defined as being the resistance of a column of mercury 106 cm. long and 1 mm. in section at 0° C. The length best satisfying the experiments is about 106·25, but it was considered best to use the round number. The experiments which I have been making under an appropriation from the Government are now barely completed, but they will probably agree very well with the latter figure. Hence we can say that we now know this unit of resistance to one part in one thousand, at least. And so we are in a position to measure the energy of a current to the same degree of accuracy, as far as this quantity is concerned.

But to measure a current by the tangent galvanometer one requires to know the intensity of the earth's magnetism, a quantity difficult to determine, and constantly varying with time and place. The electro-dynamometer, when made with care, is excellent, but a good one is immensely expensive. Our methods, then, of current measurement are bad, unless carried out in a completely equipped physical laboratory. With a practical standard of electromotive force, such as Clark's standard cell or a thermo-electric battery, this difficulty partially vanishes. Better, perhaps, we might make simple electro-dynamometers with constants determined by comparisons with a more costly instrument.

But where shall these standards be kept? Evidently the Government, which decides on our standard of weights and measures, should take in charge the electrical standards, and possibly also the thermometric standards. The formation of such a bureau of physical standards will be brought to the attention of this conference.

Having given certain standards, then, the measurement of currents and current energy becomes easy. The amount of heat generated in a wire of known resistance by a known current is also easily found from the absolute system of electrical measurement.

Besides the two so-called absolute systems of measurement of electricity and electric currents, we have also one based on the chemical action of the current whose laws were discovered by Faraday. Knowing the electro-chemical equivalent to some substance we are able to measure the time integral of the current or the total quantity of the current which has passed.

The absolute measurement of magnetism is equally simple with that of electricity, and it is a common observation to find the earth's magnetic force. But Faraday has put in our hands a very simple method of measuring a magnetic field, and to-day all are familiar with his beautiful laws with respect to magnetic lines of force. We know the laws of electro-magnetism, and just how many lines of force (better induction) can pass through a piece of iron of given cross section, and what is their relative resistance when passing through air or iron. In fact, we have all that is necessary for a complete theory of the dynamo-electric machine, and consequently we find that the latter agrees perfectly with theory, and no fact has been observed with reference to it which could not have been foreseen from theory by a person of proper intelligence.

This part of electrical science, the measurement of electrical and magnetic quantities, is thus in a very forward state, based as it is on the mathematical theory of the subject. But, in reality, this forms but a very small portion of our science. Shall we be contented with a simple measurement of what we know nothing? I think nobody would care to stop at this point, although he might be forced to do so.

We have, then, the beautiful fabric of mathematical electricity given to the world by Poisson, Green, Helmholtz, Thomson, Maxwell and others, whose names are immortal. No hypothesis as to the nature of electricity rests at its base. Starting from the most simple laws of electricity and magnetism, it rises from a stable foundation and rears its form high in air, never to be overturned, whatever the fate of the so-called electric fluid or the ultimate theory of magnetism. On the simple fact that there is no electric force inside a closed conductor, it is proved that electric attraction and repulsion varies inversely as the square of the distance. This fact is sufficient to give us the whole theory of electrostatic distribution on conductors.

From the simple fact that we can break a magnet up into parts which are similar to each other, and that these parts attract and repel each other in a certain manner, we derive many important facts with regard to magnetism.

From the magnetic action of the current we find, by an application of the great law of conservation of energy, all the laws of induced currents, either from magnets or other currents. By an almost superhuman effort of the intellect we detach our electric currents from matter, and suppose them to take place in the ether of space, and we have the grand electro-magnetic theory of light given to us by Maxwell.

But the subject is too vast to be treated in a moment. Suffice it to say that no person at the present day has the right to express an opinion on any theoretical question connected with electricity without a knowledge of its mathematics.

This study has led us to alter our ideas on many questions. What is the mechanism of electric or magnetic attraction? Faraday has given us his idea of lines of force, and has made them play an important part in the theory of magnetic induction. When treated mathematically, Maxwell has shown that all electric and magnetic attractions can be explained by a tension along the lines of force and pressure at right angles to them, an idea due to Faraday.

The mathematical theory of these lines show that all electrostatic forces between either conductors or non-conductors can be explained in this manner. As the laws of magnetic attraction are the same in every way as electrostatic attraction, if we should do away with electric conduction, it follows that magnetic attraction is to be explained in exactly the same manner. In obtaining this result Maxwell calculated the forces acting on the medium at every point, and compares these with imaginary stresses in a medium at the given point. Hence, the energy stored up can be represented either as due to the mutual attraction of the electricity at a distance, or to the stresses in the medium at every point, and thus, as Thomson has shown, by a volume integral of the square of the force at every point. Hence, we are at liberty to deny the existence of all action at a distance, and attribute it to the intervening medium, which, to be logical, we must assume to be continuous and not molecular in constitution.

Thomson has pointed out that magnetism must be of the nature of rotation, such as possibly vortex motion in a fluid, and Maxwell has done something towards making a mechanical model of such a medium. Thomson's wonderful address at Montreal has also given us much to think of in the same direction.

But here we have reached the limit of our science, and even that servant of our reason, imagination, fails us. We are yet unable to picture to ourselves what takes place in a medium subject to electrostatic action. We are face to face with the great problem of nature, and the questions, what is matter? what is electricity? evoke no answer from the wisest among us. Our mathematics have guided us safely up to a certain point, and will guide us still further; science will advance, and we shall know more. But, for the present, this is the limit which we have yet attained in this direction. However, the idea of a medium is still serviceable in other portions of our science.

We have seen that the medium explains the electrical and magnetic attraction of bodies at rest. The question then comes up as to what happens in the medium when these bodies move. Are the imaginary stresses in the medium transmitted from place to place instantaneously, or do they require time? Mathematics in the hands of the immortal Maxwell has answered this question, and we now know that any magnetic or electric disturbance is propagated through space with a velocity equal to the ratio of the electro-magnetic to the electrostatic unit of electricity. This great physical constant has now been found by experiment to be equal to the velocity of light, and thus has arisen that great modern theory, Maxwell's electro-magnetic theory of light. Indeed, at the present day, so perfectly does this theory agree with experiment, that we can almost regard it as a certainty. The velocity of light, and the ratio of the units, agree far within the limits of experimental error. The fact that bodies having a true (not electrolytic) electric conduction are always more or less opaque, the refraction and dispersion of light, double refraction and diffraction, all are explained on this theory with an ease and simplicity wanting in all other theories; and lastly, an electro-magnetic phenomenon has been discovered which, when applied to this theory of light, explains the rotation of the plane of polarisation produced by a magnet. There is no fact in nature seriously in disagreement with this theory, and it serves to connect two of our most important branches of physics, light and electricity.

But some physicists say that it is not a true theory because it is not mechanical, the object of these physicists being to reduce every phenomenon of nature to matter and motion. Whether this is necessary or not I leave to the philosophers. But it is to be noted that the old mechanical theory that light is a vibration in the medium having the properties of an elastic solid, is not entirely at variance with the new theory. The medium we call ether. The electro-magnetic theory says that the waves of light are waves of electric displacement, while the old theory says they are waves of ether. Make electricity and the ether equal to each other, and the two theories become one. We have arrived at that hazy and unsatisfactory theory of Edlund that ether and electricity are one, except that by this theory electricity is presented to us as an elastic solid!

But the ground trembles beneath us, and we shall soon be plunged in the mire of vague speculation if we do not draw back.

Among the other questions which depend for their solution on the presence of a medium, may be mentioned the mutual action of two electrified bodies moving in space. It has been found that electricity carried through space on a charged body has exactly the same magnetic effect on a stationary magnetic needle as if it had been conducted.

But when electrified bodies move uniformly forward in space, we can conceive of no mutual effect from such motion, unless it is relative to a medium. For we cannot even conceive of absolute motion.

Assuming the medium to exist, we then know that a positively and negatively charged body flying through space with the velocity of light would have their electric attraction just balanced by their magnetic repulsion, and so would exert no force on each other.

But it is a most wonderful fact that we have never been able to discover anything on the earth by which our motion through a medium can be directly proved. Carried as we suppose by the earth with immense velocity through regions of space filled with ether, we have never yet been able to prove any direct influence from this ethereal wind.

The assumption of a medium allows us to solve in some cases that problem so long under discussion by electricians, namely, the true velocity of an electric current. We now know that the term velocity hardly applies to this case, and that the current arrives at different points so gradually that we know not when to say it has arrived. But there is certainly a minimum time when even an infinitesimal current can reach a distant point. Suppose two wires stretched in space with their ends near together at one end, and a Leyden jar be discharged from one to the other at the near end. The *minimum* possible time of obtaining a spark at the distant end will evidently be the time required by light to pass from the Leyden jar to the distant point, not around the wire, but in a straight line. In this case the greatest maximum velocity is thus twice that of light reckoned around the wire, and may be any amount greater when we bend the wire. For all ordinary distances this velocity may be considered infinite, and the retardation to depend only on the electrostatic capacity and the magnetic self-induction of the wire. Treated in this way, we have Thomson's mathematical theory of the propagation of an electric wave along a telegraph wire or cable, a theory of great practical use in telegraphy and telephony. But until the action in the external medium is also taken into account, it can only be considered an approximation. For we can never move a magnet, discharge a Leyden jar, or complete the circuit of a battery, without causing a wave of electro-magnetic disturbance in the ether, and every signal which is sent along a telegraph line is accompanied by a wave in the ether, which travels outward into space with the velocity of light. Truly, the idea of a medium is to-day the keystone of electrical theory, but we can hardly suppose that it has even yet attained a fraction of the importance to which it is destined to rise.

Let me now call your attention to one of the most wonderful facts connected with electrical science. When we are dealing with the electrostatic action of electricity, we find that it is the so-called electric fluid which attracts the opposite. Not only do we observe the attraction of bodies oppositely charged, but the electricity itself on the two bodies is displaced by its mutual action. But when we come to investigate the mutual attraction or repulsion of electric currents on each other, we find an entirely different law. In this case the conductors carrying the currents attract or repel each other, but the currents within those conductors have no influence of attraction or repulsion to displace themselves within the body of the conductor. In other words, the current is not displaced by the action of a neighbouring magnet, but flows on calmly as if it were not present.

This to me is one of the most wonderful facts in electrical science, and lies at the foundation of our science. It cannot be ignored in any further progress we may make in electrical theory, but points out a radical difference between electrostatic and electro-magnetic action.

I have said there is no action of a magnet in displacing an electric current, and have thus stated the broad general fact, and which is perfectly true in some metals. But in others there is a small action which changes in direction with the material. The elements of the electric current within the material are rotated around the lines of magnetic force, sometimes in one direction and sometimes in the other, according to the material; but the action is in all cases very weak. When applied to the electro-magnetic theory of light, this action leads to the magnetic rotation of the plane of polarisation of light. As to the explanation of both of these actions, Thomson has remarked, in the case of light, from dynamical considerations, the rotation can only come from a true rotation of something in the magnetic field, and leaves us to think of all magnetic action as of the nature of vortex motion in a fluid; but here our theory ends for the present. We have obtained a clue, but it is not yet worked up.

I have now taken a rapid glance at some of the modern advances of electrical science, and we have not yet had to give up the old idea that electricity is liquid. To the profound thinker this idea is very vague, and there are some facts at variance with it, but it is still useful. We often hear persons say that this old idea is gone, and that electricity is "force," whatever they may mean by that. But let us see: the work, or energy, of an electric current between any two points is the quantity of electricity passed multiplied by the potential; this work goes to heating the wire. Let a current of water be passing in a pipe and the quantity of water multiplied by the difference of pressure between two points gives us the work which has been done in the intervening space, and which has produced heat. The analogy is complete. No electricity has been destroyed in the one case, or water in the other, but the work has come from the fall of potential in the one case, and the fall of pressure in the other; the resultant is the same in both—heat. Again, we can obtain work from the mutual attraction and repulsion of electrified bodies, and the work in this case always comes from the change of potential between the bodies while the electric charges remain undisturbed in quantity. Electricity, then, is not energy, but is more of the nature of matter.

So far for electricity in the state of rest or steady flow; but when it changes from rest to motion, all known liquids have a property known as inertia; furthermore, they have weight. But the electric fluid has neither inertia nor weight as far as we have yet experimented, and in this respect differs from all known matter. Furthermore, we have never yet been able to separate electricity from ordinary matter. When we pass electricity through a vacuum, the resistance becomes less and less, and one may have hopes of finally having an electric current through a vacuum. But, as the exhaustion proceeds, we observe that the resistance begins to increase until it reaches such a point that no discharge can take place. Electricity cannot exist, then, without matter, a fact fatal to the idea of a fluid, however useful that may be. We have but one conclusion from this, and that is that *electricity is a property of matter.* Do with it what we may it can never be separated from matter, and when we have an electrical separation the lines of force must always begin and end in matter.

The theory of matter, then, includes electricity and magnetism, and hence light; it includes gravitation, heat and chemical action; it forms the great problem of the universe. When we know what matter is, then the theories of light and heat will be perfect, then, and only then, shall we know what is electricity and what is magnetism.

It is the problem of the universe which looms up before us, before which we stand in awe. The intellect of the greatest among us appears but feeble, and we all, like Newton, appear but as children on the seashore. But how few of us find the shells which Newton did, and how few of us try. The problem is vast and the means for its solution must be of corresponding magnitude: our progress so far has been but small. When we push our inquiry in any direction we soon reach a limit; the region of the unknown is infinitely greater than the known, and there is no fear of there not being work for the whole world for centuries to come; as to the practical applications which await us, the telegraph, the telephone and electric lighting are but child's play to what the world will see in the future.

I have briefly recounted the advances which we have now made in one science, and however beautiful it may appear, we have soon reached the limit of the known, and have stood in wonder before the vast unknown. For very much of our science we see no practical applications, but we value it no less on that account; and we know by the history of the past that the progress of the world depends on our pursuit, and that practical applications, such as the world has never even conceived of, await us. It is necessary that some should go before to clear the way for the world's advance.

This is the work of the pure scientist; to him the problem of the universe is worth devoting his life, and he looks upon wealth as only adding to his means of research. He hopes not to solve the problem himself, but is contented if he may add some small portion to human knowledge; if he may but do his part in the march of human progress. He looks not for practical applications, but he knows full well that his most abstruse discoveries will finally be made useful to mankind at large, and so troubles himself no further about it.

The science which he creates is studied by others; their minds are educated by it, and their hearts entranced by its beauties; and some are led to devote their lives to its further advancement; but the whole world benefits by it intellectually. The wayward spirit of the amber is banished for ever, and prosaic, law-abiding electricity has taken its place even in the estimation of the most ignorant. The world has advanced, and in great part from the study of science.

Then comes the practical man who sees that other benefits can be reaped besides those of pure intellectual enjoyment. While the investigator toils to understand the problem of the universe, the practical man seeks to make a servant of our knowledge; he seeks to increase the power of our bodies and so make the bonds by which the mind is united to it less irksome. It is he that increases the wealth of the world and thus allows those so disposed to cultivate their tastes and to elevate themselves above the savages. The progress of the world depends upon his invention.

Let not, then, the devotee of pure science despise practical science, nor the inventor look upon the scientific discoverer as a mere visionary person. They are both necessary to the world's progress, and they are necessary to each other.

To-day our country, by its liberal patent laws, encourages applied science. We point to our inventions with pride and our machinery in many of the arts is not surpassed. But in the cultivation of the pure sciences we are but children in the eyes of the world. Our country has now attained wealth, and this wealth should partly go in this direction; we have attained an honourable position in applied science, and now let us give back to the world what we have received in the shape of pure science. Thus shall we no longer be dependent but shall earn our own science as well as inventions.

Let physical laboratories arise; let men of genius be placed at their head, and, best of all, let them be encouraged to pursue their work by the sympathy of those around them. Let the professors be given a liberal salary so that men of talent may be contented. Let technical schools also be founded, and let them train men to carry forward the great work of applied science.

Let them not be machines to grind out graduates by the thousand, irrespective of quality; but let each one be trained in theoretical science, leaving most of his practical science to be learned afterwards, avoiding, however, overtraining. Life is too short for one man to know everything, but it is not too short to know more than is taught in most of our technical schools. It is not telegraph operators but electrical engineers that the future demands.

Such a day has almost come to our country and we welcome its approach.

Then, and not till then, should our country be proud and point with satisfaction to her discoveries in science, pure *and* applied, while she has knowledge enough to stand in humiliation before that great undiscovered ocean of truth on whose shores Newton thought he had but played.

When the applause which greeted Professor Rowland's speech had ceased, Sir Wm. Thomson was called upon, and responded amidst very hearty manifestations of esteem from the audience.

ADDRESS OF SIR WILLIAM THOMSON.

In the beautiful address which has been delivered, we have an admirable exposition of the relations between pure science and the applications of science to the wants of mankind. We have had a beautiful vindication of the independence and dignity of pure science, and we have had a most liberal and intelligent exposition of the action and reaction of those two great forces continually having effect in respect to the relations between pure and applied science.

The work of a great mathematician and a great philosopher, applied to a matter of abstract justice, is here purely and interestingly exemplified. But alas for science that Newton should have been Master of the Mint, and only Master of the Mint, for the last years of his life. We have had, indeed, some evidence new to the world, brought recently before the British Association at Montreal, to the effect that Newton really had done many things that do not appear in his "Principia" or in his "Optics," or in his "Universal Arithmetic," or in any of his works hitherto published, and that a sense of public duty alone prevented him not only from going on and investigating more, but even kept him from publishing that which he had done, and which remains in manuscript to this day, proving that he was far ahead of anything that was then known in respect to some of the principles in physical astronomy and optics that have been worked out since his time by persons following in his steps.

I say that this electrical conference, of which this is the first meeting, is to be viewed as a piece of the liberal progress of the nineteenth century of the great nations of Europe and America, according to which science and its practical applications go hand in hand and mutually act and interact beneficially.

An electrical conference, such as we are now entering upon, with the objects that have been put before us by Profs. Newcomb and Rowland, is of the most superlative use, not merely for the practical purposes for which it is designed, but for the recognition of applications to practical purposes, which all men, who cultivate science, must feel to be most potent in guiding their own work, even in the most transcendental regions of thought. The special objects of this international conference are partly carrying out, and partly expanding those which have been put forward by a committee of the British Association as long ago, I think, as 1862, and then again by the Conference of Electricians in Paris, which was held in the years 1881–82–83.

The introduction of an international system of electrical measurement, as it has been spoken of by Prof. Rowland, is one of the most important subjects that will come under discussion of this conference.

Rowland's investigations on the magnitude of the ohm help to give us the foundation to bridge over the absolute measurement of currents—such as those of Langley's—which require the determination of the hundred-thousandth, or the millionth of an ampere, to the current of an incandescent lamp, such as an Edison lamp of six-tenths of an ampere, and the current of 5,000 amperes. When we have a central station, such as that which is so admirably worked out by Edison, and which will come to be worked out more and more, in New York and all cities of the world, by which one large station shall give light to every place within a quarter of a mile of it; the wants of practical measurement for electricity will correspond quite in magnitude to the wants of ordinary weighing.

We want not only instruments that shall be as convenient as the fishwife's spring balance for weighing fish, or the quick automatic balance for weighing a railway truck; but we want quick, accurate instruments, prepared from absolute standards. As has been stated by Prof. Rowland, the comparison of practical instruments with absolute standards is one requiring the super-refinement of scientific methods, and the hardest work of the scientific investigator in his laboratory.

Lord Rayleigh has done this to a remarkable degree. He has produced an absolute electro-dynamometer, free from the objections that Prof. Rowland has spoken of with regard to the difficulty of measuring the continually varying wave of terrestrial and magnetic force.

This instrument is now in the Cavendish laboratory in Cambridge, England. The comparison of this with other instruments requires the difficult transportation of instruments, or the very difficult method of electro-chemical measurement which has been described to us.

The great object of an international conference must be the laying out of convenient standards; a convenient, absolute milli-ampèremeter, and a convenient absolute hecto-ampèremeter which will measure a few hundred ampères in a convenient way. The establishment of such instruments in all the cities of the United States and Europe is one of the first objects of the Electrical Conference. We must not hope too much from this one conference. If it opens the way to carrying out such an object, those who have worked as some have done for the public good in the way of promoting the institution of this conference will have their reward.

I fear I have taxed your patience too long, but I cannot sit down without again reflecting on the men whose lives have been patterns to the world. There is none more remarkable, perhaps, than the man of this country, Joseph Henry, who ended his days here. He and Faraday were patterns of scientific investigators. In some degree they went parallel, and made similar scientific discoveries. Henry, indeed, preceded Faraday in the great discovery of the electro-magnetic induction between unmoved conductors. Henry gave the warmest welcome to all practical applications of his discoveries. He sought to make none himself, not because he superciliously despised the applications of science to the public good, but because his own convictions constrained him to go on in pure science; because he felt, as Prof. Rowland has said so well in respect to Faraday, that it would have taken him from his work to have devoted himself at all to the practical applications of his discoveries. But what a beautiful trait of character it is to see what a kindly welcome he gave to those who did make the practical applications. He saw what might be done, but deliberately left it to others.

I know no other parallel to Henry's action in this respect except that of Faraday himself. The beautiful and simple manner in which Faraday describes the dynamo, which is making such a mechanical and engineering revolution in the world, is remarkable: "Put a little more wire together, make the thing a little larger, and there is a vast power there, competent to do great things." I wish I could remember his words. He says in the very simplest manner that he must leave this to others. "I have to go on; I have something before me that I must do. This will be done. This will come, perhaps, but not by me." I have only been able to clumsily repeat the idea in ten times the number of words, as I remember it, from reading his paper a long time ago. He thought little of the practical application; but it was not one of those gifts given with an off-hand generosity because the giver did not value it. Faraday valued the practical application. He was, like Newton, in the public service as an engineer. He was scientific adviser to the English Board of Lighthouses, as Henry was to the U.S. Board of Lighthouses.

The friendly welcome that Faraday gave to the dynamo is quite refreshing to think of. When he was first shown a great dynamo with power enough to produce the electric light, he said: "I gave it to you as an infant, and you bring forward the child as a giant." No one took a greater pleasure in the application of his science than Faraday. He was content to stand by and see the great results that were obtained, while he remained at work in the Royal Institution to the very end of his working days, trying to see deeper and deeper into the properties of matter, and trying to penetrate further along that line of investigation you have heard described so admirably by Prof. Rowland, the relation between electro-magnetism and gravitation.

I must say, in conclusion, that I greatly wish success to the Electrical Conference in its two-fold object of promoting the useful applications of science to the ordinary wants of man, and, on the other hand, to give tone and character and vigour, in one respect, to the purely scientific investigator, and to give him the means of observing and seeing, to bring forward to him suggestions, which the most ardent student in the laboratory or the mathematician in his retirement could scarcely arrive at without observations of the phenomena, which are brought before him in these great applications of science, such as we see now in electric lighting and electric transmission of force by the dynamo-electric machine.

THE PETROLEUM-MOTOR.

By SIEGFRIED MARCUS, of Vienna.

The magneto-electric ignition apparatus.

One of the chief advantages of the gas engine as compared with the steam or the hot-air engine is, that the former takes its supply *cold.* The time is thus economised which in other motor engines is wasted in firing up.

It is ready to act at any moment without any time being lost in preparation.

The gas motor shares this valuable attribute with the water motor. But just as the latter is dependent on its water main, so is the former bound to the gas pipes. Both are applicable only where the corresponding installations for their supply are in existence. Hence follows the limited application of these machines, since gas and water are not to be had in every place where a source of power is required. Indubitably the gas engine is inferior in this respect to steam or hot air engines. From this circumstance it follows that the gas engine in its present form is applicable only as a fixed, non-movable machine—a further limitation of its utility.

These considerations induced me long ago to construct an explosion motor which can be disconnected from the gas pipe, set up anywhere, and be at once capable of action; in a word, to make the explosion motor movable.

In this I have been at last completely successful.

It need scarcely be mentioned how important is such an improvement on the gas explosion engine.

Not only is the new motor capable of advantageous use in agriculture, forestry and mining, it is adapted as a locomotive to all kinds of conveyances on land and on the water; at any moment and at every place it can serve for the production of the electric light (with the aid of a dynamo machine), whilst in the railway service it is fit for working station pumps, turntables, cranes, &c.

I pass over the many difficulties which I encountered in the pursuit of my object and remark merely that I found, on closer examination, that three special problems required solution:

1. The simple production of a cheap explosive mixture, suitable for working an engine, coal-gas being excluded.
2. A method of igniting such a mixture without the use of coal-gas or of galvanic elements.
3. A suitable construction of the mechanical part of the machine, with reference to the points 1 and 2.

As point 2 will be especially interesting to the readers of this paper, I will in the first place describe the arrangement patented to that end, following the published specification.

The ignition of the detonating gas in gas or any other explosive engine, has hitherto been effected in two manners, either by a Ruhmkorff's spark-inductor or by means of gas flames. Both methods have their disadvantages.

I will merely mention that the use of a spark-inductor presupposes a galvanic battery, the management of which is costly and inconvenient. Ignition by means of a gas flame requires not only an extremely well-fitting mechanism, but a continually burning gas flame, which impinges directly on the driving cylinder and conveys to this—which is strongly heated by the rapid succession of explosions—a further supply of injurious heat, which must then be compensated by corresponding quantities of water for cooling.

All these disadvantages are evaded by my invention of ignition by means of a magneto-electric inductor in connection with a peculiar automatic igniter. This depends upon a very simple mechanism, requires absolutely no attention (since the explosive machine when at work produces the igniting electric current at an infinitesimal outlay of power), and acts at once uniformly and reliably.

On the principle of the ignition arrangement.

I ascertained by means of special experiments that the spark formed on interrupting an electrically-induced spiral in the moment of the demagnetisation or polar change of the iron present in the spiral at the points of interruption, is best suited for igniting detonating gas. I therefore founded the new ignition arrangement upon the direct and immediate utilisation of the interruption spark formed by the extra current.

As the construction of the requisite apparatus requires a peculiar mechanism, I give its peculiarities from the two following points of view:—

1. The ends of the magneto-electric spiral terminating in the igniter (*i.e.*, the point where the kindling-spark is to be formed) must have such an arrangement that they (unlike all previously known electric igniters), alternately come in contact with each other within the explosive space, rub together and again separate. Hence, either both ends of the igniter must be movable, or at least one of them.

FIG. 1.

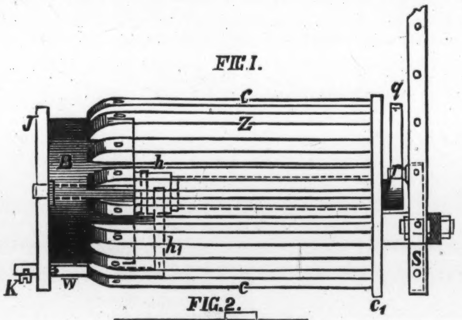


FIG. 2.

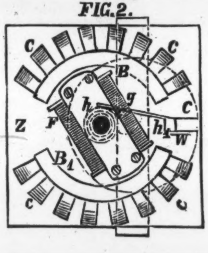
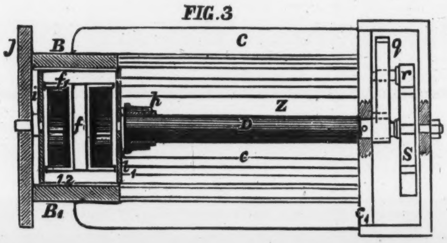


FIG. 3



2. The movements of this igniter must correspond in such a manner with the movements of the magneto-electric apparatus producing the current, that during the magnetisation of the inducing iron keeper the metal contact pieces of the igniter touch each other and, on the other hand, separate from each other rapidly and with friction in the moment of demagnetisation or of polar change.

On the basis of the above two points there may be used for the production of a current:

a. Continuously rotating magneto-electric apparatus.

b. Magnetic inductors which react electrically on a momentary mechanical impulse, producing a spark, or several sparks.

The ignition arrangement which effects the combustion of explosive gases or vapours in motors directly, *i.e.*, without the aid of a so-called magneto-electric spark inductor (Ruhmkorff), is represented in the accompanying figures. It consists essentially of a magneto-electric current-producer set in action by a peculiar mechanism, in connection with an automatically acting friction-contact placed in the explosive space of the cylinder.

The figs. 1, 2, 3 and 4 show the magneto-electric current-producer in side elevation, front elevation with the plate, J, removed; in longitudinal section and in ground-plan.

The pieces, B and B^1 (figs. 2 and 3), cut out of a cylindrical iron ring, form the poles of a powerful compound magnet, consisting of a number of bar magnets, *c*, *c* . . . and of the iron plate, c^1, which is screwed to them. A quadrangular iron plate, J, formed of any non-conducting material, preferably caoutchouc, the purpose of which is stated below, covers and secures the ring-shaped front side.

As is shown in fig. 2, the bars, *c*, *c* . . . are arranged radially around the ring-pieces in such a manner that each half of the bar-magnets is united in a common magnetic pole. Of course the bars can be connected with the polar caps in some other form, *e.g.*, in a straight line.

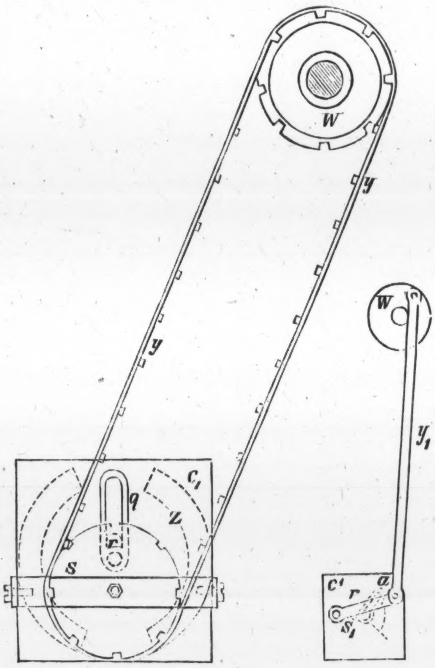


FIG. 4.

FIG. 5.

Between the poles of this magnet is the iron keeper, *f* (fig. 3), capable of turning on the axle, D. It consists of an intermediate cylindrical piece, *f*, and of two end plates, f^1 and f^2. Around the cylindrical part of the keeper there is coiled on an insulated bobbin the carefully insulated copper spiral *g* (fig. 2), the beginning of which is firmly connected with the metallic body of the apparatus and the end with the ring, *h* (fig. 3), fixed upon the axle, D, but insulated from it. The two plates, *i* and i^1, screwed to the keeper serve to secure and connect the axle, D (consisting of two parts), with the keeper, *f*.

Between the ring, *h* (fig. 1), and the terminal K, the contact spring, h^1, forms with the metal piece, W, a metallic conductive connection. The terminal, K, is fixed to the covering plate, J. The axle, D, has its bearings on the one hand in the plate, J, and on the other in the iron bottom plate, c^1, and projects out through both of them.

A peculiar feature in the construction of the mechanism described above is the crank contact.

To the axle, D, is fixed a lever, *q*, which is carried round by the pin, *r* (figs. 1, 3 and 4). This pin, *r*, is on the disc, S, which is fixed eccentrically on the axle, D, and is put in motion by means of a strap, *y* (figs. 1 and 4), from a driving wheel, W, set in rotation by the engine for which the ignition apparatus is to serve. By means of this crank contact an unequal speed is communicated to the axle, D, and hence to the inducing keeper.

The equably corresponding motion of the discs, S and W, is of importance for the precise working of the igniter. It can be obtained in any desired manner, *e.g.*, by means of a chain or a steel band, *y*, covered with projections, and passing over the discs, S and W, which have depressions into which these projections catch, thus preventing it from slipping. It can be quite as well effected by an oscillatory movement, whereby, likewise, a crank contact is employed.

As is shown in fig. 5, the rod, y^1, fixed eccentrically to the disc, W, sets the lever, S^1, whose pin, *r*, lies in the slit of the lever, *q*, in an oscillatory movement.

By the arrangement of extending the polar caps of the compound magnet to the entire width of the iron pieces on the one hand, and on the other by applying the crank contact movement to drive the induction spiral, the keeper, during its rotation or oscillation, is exposed as long as possible to the inductive action of the compound magnet (in order to obtain the highest possible magnetic saturation), whilst the interruption of the current ensues rapidly.

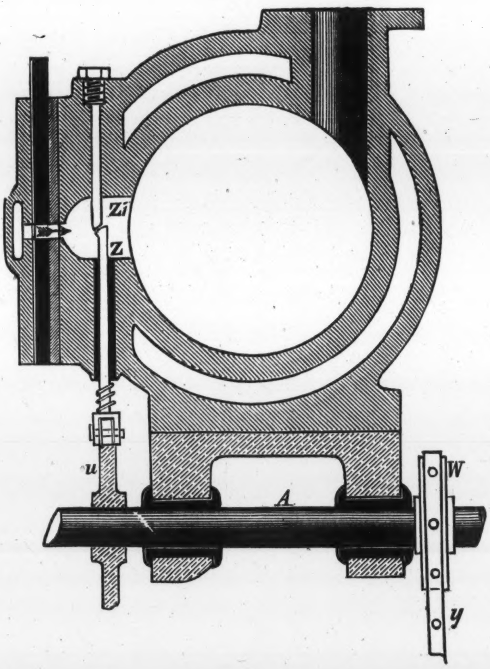


FIG. 6.

On the axle, A (figs. 6 and 7), is fixed a disc, *u*, which slowly moves the ignition pin Z (which passes gas-tight and insulated into the explosion space), and lets it fall rapidly over the projection, u^1. Opposite the free end of the pin, Z, is a pin, Z^1, on the opposite side.

When the pin, Z, is pressed in, which takes place but slowly in consequence of the arrangement described above, the free ends of the pins, Z and Z^1, projecting into the explosion space come into contact, and are then withdrawn very rapidly from each other as the suddenly sinking curve of the disc, *u*, involves. By this rapid removal there arises an electric interruption spark, by which the gaseous mixture in the explosion space is ignited and exploded.

I point out here particularly that the ignition mechanism acts permanently well only when these contact-forming pins slide over each other whenever they touch, thus keeping their surfaces clean, and securing conductivity. This friction of the contact-makers has the further advantage that minute particles of metal are carried away, and on the formation of the spark are ignited, whereby the kindling power of the spark is greatly heightened.

If blunt contacts are used, the conductivity of the pins decreases so rapidly after a few explosions (as they become coated with the products of combustion) that the apparatus in a short time ceases to act.

It might here be thought that the friction of the steel contacts must rapidly wear them out; this is not the case. According to experience they stand a year's normal working before they need to be replaced, which costs only a few pence. An interesting phenomenon is here noticed; those parts where the spark springs over, in spite of the heat produced by the combustion of the detonating gas, become almost as hard as glass, which may explain their durability.

For better understanding, the construction of the contact makers is shown in detail in the accompanying figures 8 and 9.

The friction of the contacts against each other can be effected either by a rectilinear to and fro motion of one pin (or of both), or by the rotation of one of them. As already explained, the rectilineal movement of the ignition pin, Z, is effected by the disc, *u* (figs. 6 and 7). The rapid separation of the contact makers is effected by the projection, u^1, and by the action of a small spiral spring applied to the pin, Z. In fig. 8 is shown the extreme position of Z with reference to Z^1, which makes the friction movement intelligible.

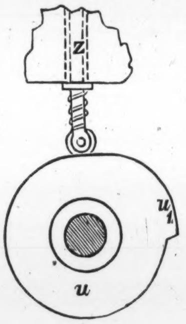


FIG. 7.

FIG. 8.

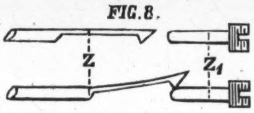


FIG. 9.

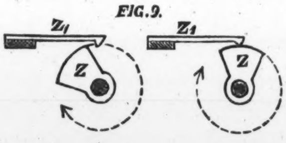


Fig. 9 represents a modification in which one of the contact-makers is fixed, whilst the other, having preferably the form of a segment, is set in rotation by any suitable mechanical arrangement (*e.g.*, by conical wheels) in such a manner that they rub against each other on touching, and their rapid separation takes place at the moment when the gaseous mixture is to explode.

It may here be remarked that the segment shape of one of the contact makers is not indispensable. Another form may be substituted as long as the principle remains (*i.e.*, a brief rotatory rubbing contact, followed by a rapid interruption.)

The patent claims :—" For the purpose of the electric ignition of explosive gases or liquids the use of a magneto-electric current generator, in combination with a friction contact maker, consisting of two parts electrically insulated from each other, which (in the interior of the explosion-chamber) are alternately brought into sliding contact and then withdrawn from each other, it being noted that in order to obtain a very powerful spark both parts of the contact maker touch each other during the magnetisation of the inducing keeper, slide or rub on each other during such contact, and are then rapidly withdrawn from each other during the moment of demagnetisation."—*Zeitschrift für Elektrotechnik.*

GAS ENGINES.

AMONG others, says the *Journal of Gas Lighting*, M. Witz, a French professor of physical science, has contributed something to the stock of knowledge on the subject—not exactly of a hot-cylinder engine, but of the need for it. In a recent paper, published in the *Journal de l'Eclairage au Gaz*, Dr. Witz enlarges upon this subject in a highly instructive manner. The title given by Dr. Witz to his paper is "*De l'action de paroi dans les moteurs à gaz tonnant*;" *paroi* in this case meaning the sides, periphery, substance, &c., of the cylinder. It implies, in short, the whole material and structure of any vessel in relation to its content; and is a most expressive word, particularly when used in connection with a gas engine cylinder.

Dr. Witz begins his memoir with the declaration that the *paroi* of a cylinder plays an important part in heat engines. Its action in the steam engine is well known: the steam which comes from the boiler encounters a wall of cast iron, perfectly clean and comparatively cold, upon which it immediately condenses. The metal accordingly becomes covered with a film of liquid more or less thick, which vaporises afresh during the periods of expansion and exhaustion. Thus there is partial condensation during admission of steam to the cylinder, followed by evaporation during the other working periods; the consequence being a loss which can only be ameliorated by the use of a jacket of live steam. This jacket reduces condensation during the first period, and supplies to the walls the heat carried off during the second period. The result of this double action is to increase the work during the period of expansion, and to annul the loss in the condenser by reducing to the minimum the quantity of water enclosed in the cylinder at the end of the stroke.

The best modern constructors are now careful to steam-jacket not only the sides of steam cylinders but also the ends, and even the pistons. From his own experience Dr. Witz values the saving thus realised at 15 per cent.

That the action of the *paroi* is not less noteworthy in gas engines might be affirmed *a priori*; Dr. Witz takes upon himself to demonstrate that it is much more important. All gas engines exceeding one or two horse-power are surrounded with a cold-water jacket. The heat removed by this is enormous. In an excellent "Otto" gas engine experimented with by the author at the Roubaix Gas Works, it was found that the heat lost in this way was 40 per cent. of the disposable energy, and 48 per cent. of the utilisable heat. M. Tresca found a loss from this cause of 52 per cent. with a Lenoir motor. All the waste resulting from imperfect expansion, the discharge of hot gases, and the passive resistance of the machine disappeared in this colossal waste. In the "Otto" engine referred to, which was well constructed, well looked after, and worked perfectly, the normal consumption of gas was not usually more than 1,000 litres per hour. To move it without any load, the consumption was 400 litres per hour per nominal horse power, or nearly half its requirement for full work. All this heat went into the water tank or into the air with the exhaust.

This is the grave and ruinous imperfection that designers have so long sought to correct. Indirect solutions of the problem have been attempted, but the result of these attempts has, however, been only mediocre. It would seem to be necessary in the first place to know perfectly the working of these motors; to analyse the phenomena which take place behind the piston, before seeking to improve the performance. In a word, it has appeared advisable that the physicist should precede the engineer. Dr. Witz has endeavoured to personate the former character, with the aid of appliances placed at his disposal in the laboratory of the Lille Faculty of Sciences.

It was determined to produce, as it were artificially, the phenomena of explosion and expansion which succeed each other behind the piston of a gas engine, varying these in their principal circumstances.

The memoir then proceeds to give in detail the method of calculating results from the data thus obtained. Dr. Witz recognises that the phenomena arising from the combustion of explosive bodies have been studied by many investigators. He points out that these experiments were all made in closed receptacles, without expansion; while, by his arrangement, expansion is elevated into a considerable factor, and the results are presented in a new light. The employment of high expansion presents, in particular, the double and precious advantage of limiting temperature and reducing the pressure developed by the explosion. By limiting the temperature, the effects of dissociation, which do not appear under 1,500° C, are also avoided.

When commencing the experiments it was found that illuminating gas offered most serious difficulties because of the variations of composition from one day to another in the gas supply of the same town. Certain experiments conducted in February could not be connected with those of June, although made under identical conditions. These variations in the heating power of coal gas necessitated special researches with an explosive mixture of constant composition. Eventually a mixture of carbonic oxide and air was selected; the former being produced by the action of sulphuric acid upon yellow prussiate of potash, the accompanying hydrocyanic acid being retained by a washer and the washed gas stored over water. Dr. Witz gives the heat developed by the explosion of a volume of this gas with varying proportions of air. The common coal gas of the Continental Union Gas Company, of Lille, has a calorific power of 5,520 calories per cubic métre. The complete combustion of this gas requires $5\frac{1}{2}$ times its volume of air, developing by the explosion of this mixture a temperature of 2,200° C., and a pressure of nine atmospheres. By mixing the gas with 9·4 volumes of air the temperature of explosion does not exceed 1,600° C. in a constant volume.

The first object of the author's experiments was to observe the effect produced upon an explosion by the velocity of expansion. Briefly, without reproducing the details given in the memoir, it appears that for carbonic oxide, as for coal gas, the useful work increases with the velocity of expansion. A complete analysis of the phenomenon, permitting the author to follow the rapidity of combustion, has shown him that as the velocity of expansion increases, combustion is by the same fact rendered more rapid. In short, Dr. Witz has been led to formulate these two theorems: (1) Utilisation increases with the velocity of expansion, and (2) combustion is so much the more rapid as the velocity of expansion is more complete. These laws are of fundamental importance in connection with gas motors. In fact, this great influence of the velocity of expansion is but a consequence of the action of the *paroi*. How can the modification of all the phenomena of explosion by the velocity of expansion be otherwise explained? It can only be by the cooling of the metallic surface, which, exercised during a shorter or longer time, subtracts heat proportionately from the explosion-centre and diminishes the intensity of the reaction. It is not only the rapidity of combustion which is subject to this influence, but the surface of the diagram itself is reduced; the work diminishes, and the utilisation falls, as already stated. To extract the best possible portion of the heat disposable from explosive mixtures it is necessary, therefore, to arrange the expansion of the products of combustion in the shortest possible time, and to reduce the surface of the cylinder to the minimum; that is to say, to reduce $\frac{\text{surface}}{\text{volume}}$ to the minimum. There will be also recognised the great advantage of realising the maximum Q : V (the proportion of the quantity of disposable heat to the volume occupied by the explosive mixture). In other words, the real practical as well as theoretical advantage of compressing the air and gas before ignition will appear.

A great deal of the superiority of motors of the "Otto" type, is due to the extreme rapidity of expansion of the gas in their cylinders. The action of the *paroi* is, therefore, the great regulator of explosive phenomenon. It is competent to accelerate or slacken combustion, to produce slow and gradual combustion; it performs some functions in this respect sometimes ascribed to dissociation. Dissociation is not necessary to explain them, however, for they can be reproduced in cylinders wherein the temperature does not surpass 1,400° C. Dilution renders this slow combustion more apparent; but the phenomenon of prolonged combustion can be produced independently of dilution. This perfectly logical deduction invalidates and confirms by turns the theory sustained by Mr. Dugald Clerk. With Mr. Clerk, Dr. Witz holds M. Otto to be in error in trying to retard combustion, which is an imperfection. Unfortunately, this retardation cannot be avoided altogether. Why? According to Mr. Clerk, because of the progressive development of dissociation, together with combustion in the explosion chamber; according to Dr. Witz, because of the action of the *paroi*, which can be only reduced, not totally suppressed. Dr. Witz agrees with Clerk's affirmation that Otto's success is due to compression alone, and not to the extreme dilution of the explosive mixture by the products of the combustion of a previous charge.

In order to prove yet again the importance of the action of *paroi*, Dr. Witz experimented with the cylinder maintained at various temperatures. The result in all cases showed the preponderating influence of refrigeration, which deforms the cycle and lowers the duty of gas-engines. As to the possibility of improving this class of motors, Dr. Witz is sanguine. Still he holds that the "Otto" type of engines is better than anything that has yet appeared. The "Otto" engine will work more economically and with perfect safety, the author declares, if the circulating water be warmed to 75° C. In the next place he strongly advises that all gas-engines should be worked to their utmost capacity. Anyone requiring a force of so many horse-power should obtain an engine of the same power, and not suffer himself to be seduced into purchasing a larger one. To work the "Otto" engine to its full capacity with hot water is therefore the sum of Dr. Witz's practical advice to power users. As to engineers, he declares that the hope for the future of the gas-engine rests in modifying the cooling influence of the cylinder.

ELECTRICAL UNITS.

MR. PREECE'S paper "On the Watt and Horse-power," read before the British Association at Montreal, and reproduced in our issue for September 19th, contains a suggestion, or rather a demand, which it is difficult to consider seriously. It is nothing less than that engineers should alter the standard of horse-power in order that a so-called convenient unit may be employed by electricians. In sober earnest, he asks engineers to raise the standard of horse-power from 33,000 foot-pounds per minute to 44,233 foot-pounds. The circumstance that there is not the most remote prospect that Mr. Preece's desires will be complied with in this respect is of little moment. If Mr. Preece and his disciples insist on having their way, and regarding a horse-power as 44,233 foot-minute-pounds, while engineers adhere to James Watt's rule, confusion worse confounded will be introduced in the commercial matters, which are really all important, at least as far as electric lighting is concerned. The term indicated horse-power conveys a meaning of the most definite kind, which has been indissolubly connected, for more than half a century, with all manufacturing operations, such, for example, as cotton spinning, to say nothing of pumping water, winding coal, and the propulsion of ships. At the present moment there is not in the whole world 10,000 indicated horse-power used in the production of electricity —not as much power, in fact, as is developed within the hull of the Atlantic steamer *Oregon*. Probably not more than a few dozen electricians ever have had to use the term horse-power at all. The demand that for their convenience the rest of the world should alter a most important standard is saved from reprobation only by its extreme absurdity. Mr. Preece finds that to divide by 746 is inconvenient and troublesome; therefore he proposes to substitute a new constant, viz., 1,000, for it, which, of course, entails the necessity for raising the horse-power standard in the proportion 746 : 1,000 : : 33,000 : 44,233. The only conceivable justifiable reason for making this change would be that very large numbers of calculations had to be made involving the use of such a constant. As, however, such calculations are seldom made, even by a few engineers and electricians, it is obvious that Mr. Preece coolly proposes to introduce a most important innovation for the sake of a minority altogether insignificant as far as either numbers or commercial transactions are concerned. Mr. Preece finds fault with the 33,000 foot-pound standard, as an "arbitrary" unit. It is really based on the results of experiments conducted by James Watt, who found that when he began to sell engines he must adopt some standard to sell them by. He caused powerful horses to draw weights up from a deep well, with the result that a strong horse raised 22,000 lb. one foot high in a minute. Determined that his customers should have no cause of complaint, he resolved that each of his horse-powers should exceed a real horse-power by 50 per cent., and took 33,000 foot-pounds per minute as his standard. So far it is, no doubt, arbitrary, but we have yet to learn that it is in any sense the worse for that. We may, however, retaliate, and state that the volt and the ampère are both, in the fullest sense of the word, arbitrary; and not only are they this, but it has hardly yet been settled what an ampère or a volt really is. The ohm has been discussed at conference after conference, and even at the last moment Siemens' standard has been accepted with considerable reluctance. This standard is a column of pure mercury, one square millimetre in section and one metre long; but standard ohms actually constructed with every possible refinement do not give an ohm resistance, but an approximation only, varying between ·9545 and ·9554. In like manner the volt is based on nothing more substantial than the fact that a certain form of Daniell's cell has an electromotive force of about ·98 of a volt. There is no reason whatever why a different cell should not be used giving a different standard. The worthlessness of the existing standards is shown by the fact that they cannot be used without a coefficient, the amount of which is indeterminate.

It may be urged that we are only dealing with practical units, while we ought to speak of the theoretical units on which they really rest; but it would be useless to deal with theoretical units if it could be shown that the practical volt and ohm were fixed in amount by practical standards, and could not be altered.

For some more or less inscrutable reasons, electricians have adopted what is known as the centimetre-gramme-second, commonly known as the C.G.S. unit of power; that is to say, instead of the foot-pound per minute, they use $\frac{1}{28}$th of an ounce moved about half an inch per second. Thus, for instance, the work done by a current of one ampère in overcoming a resistance of one ohm is $\cdot 9545 \times 10^9$ C.G.S. units. The erg referred to by Mr. Preece is $\frac{1}{13{,}825}$ of a foot-pound. Instead of saying that an arc lamp requires ·469 horse-power to work it, the electrician tells the engineer that he wants 213,969,525 ergs. per lamp. It is to facilitate the introduction of a convenient unit like this erg into workshops generally that Mr. Preece would have us abandon Watt's standard of horse-power. Let us be clearly understood. We have no fault to find with Mr. Preece or his brother electricians, if they find their C.G.S. unit answer their purpose better than the foot-pound; but we do object to attempts being made to force it on engineers. In the days when telegraphy represented the only practical work done by electricians, the quantities dealt with were extremely small —a message may be sent across the Atlantic with a battery made of a copper percussion cap, a morsel of silver, and a drop of dilute acid. But all this has been changed by the introduction of the electric light and electric railways, and the dyne and the erg are in no way suitable to the commercial wants of the engineer who has to supply the electric light and electric railways. If, as we have said before, these units were based on any unmistakeable standard, there might be something to be said in their favour, but they are not. "By way of assisting the memory," writes Prof. Everett in his excellent little book "Units and Physical Constants," "it is useful to remark that the numerical value of the ohm is the same as the numerical value of one earth quadrant per second, since the length of a quadrant of the meridian is 10^9 centimetres." Now this is just what it is not. It was believed to be so when the French metrical system was established. It is now known that the metrical system has no accurate physical basis on any terrestrial measurement of length. We do not assert that it is either the better or the worse for this, but we venture to think that it puts the words "arbitrary standard" out of court as an argument to be used by Mr. Preece against received engineering units.—*The Engineer*.

THE "BELFAST" ARC LAMP. (NEWTON'S PATENT.)

THE drawings given herewith represent an electric arc lamp of simple construction, invented by Mr. Newton, electrician to the "Belfast Electric Appliances Company, Limited," and which, we understand, has been working for some time most successfully in several places in Belfast and the neighbourhood, and has frequently been employed in the illumination of public halls for bazaars, balls, &c., its extreme steadiness rendering it specially suitable for such purposes.

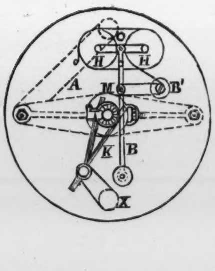


FIG. 1.

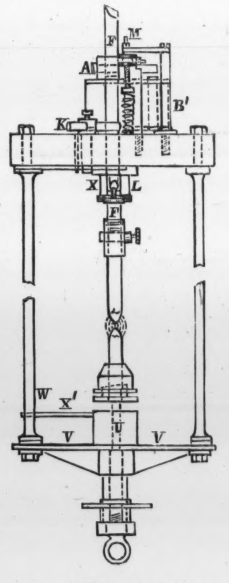


FIG. 2.

Figures 1 and 2 represent a plan and elevation of the lamp with the cover removed. The current enters the lamp at X, passing through the split wire brush, K, to the positive carbon holder, F, thence through the carbons and arc to the electro-magnet, U, through the connection, X^1, to the rod, W, which is insulated from the bridge, V, to the negative terminal.

A very small portion of the current is shunted to actuate the feed of the lamp, and passes from the rod, F, through the feeding arrangement, A, to the bar, B, and thence to the pillar, B^1, by the contact at M, N, seen more clearly in figs. 3 and 4.

From B it passes round the electro-magnet, H, H, and thence to the negative terminal.

The main point of novelty and interest in the lamp consists in the device employed for feeding the carbons forward as consumed. The carbon is pushed forward by a very minute step-by-step motion.

The action of the apparatus can be best explained by a reference to the accompanying detail drawings, figs. 3 and 4.

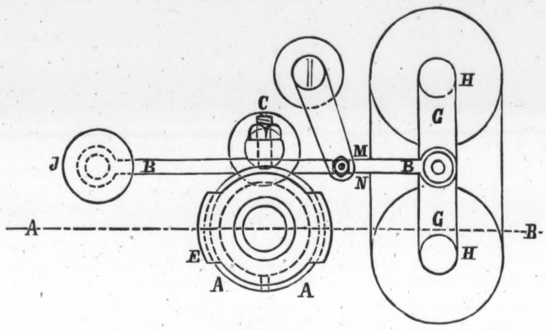


FIG. 3.

A is a hollow cylinder of brass split down on one side (to enable its diameter to be slightly varied), and firmly attached at the opposite side to the arm, B, which can rock about the central pivot, C, working in a pedestal support attached to the framework of the lamp.

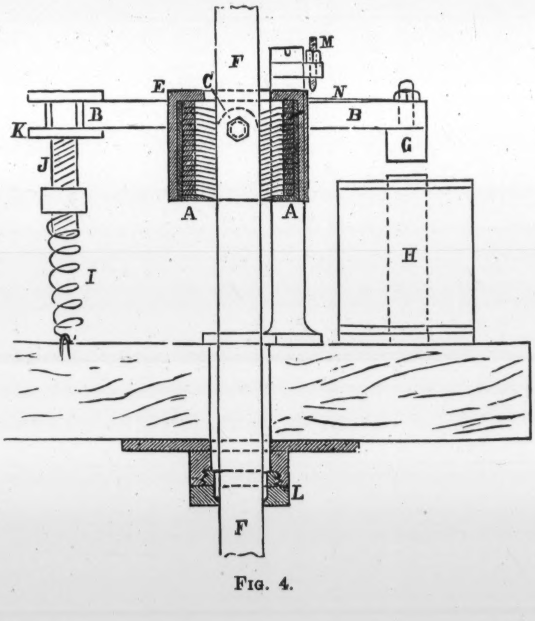


FIG. 4.

Within A is a lining made of hard steel wire fixed in a stout leather backing, shown in section. A cap, E, fits over A, and when pressed down into position shown in the section closes the split cylinder, causing the wire lining to grip the rod, F, with sufficient pressure to hold it and the carbon firmly in position. One end of the bar, B, carries an iron armature, G, at a short distance from the poles of the electro-magnet, H, H, whose coils form a shunt to the arc. The other end of B is attached to the tension spring, I, by the adjusting screws, J. L is a brush guide fitting the carbon-holder rod, F. M is a platinum-pointed contact screw attached to a pedestal which, by making contact with the small spring, N, completes the circuit through the coils of the electro-magnet, H, H.

The action of the device is as follows:—

As long as the length of the arc remains normal, the attraction of H upon the armature, G, is not sufficient to overcome the force of the spring, I. When, however, the arc exceeds its normal length, the shunt current is increased, and the magnet, H, draws down G until the contact at M, N, is broken, when the spring at once draws G sharply up again to its former position; the making and breaking of the shunt circuit, thus establishing a sharp vibration of the bar, B, and attached clip.

Now the effect of this rocking motion of the arm, B, is to cause the opposite sides of the clip, A, to rise and fall in sharp alternation, and owing to the downward inclination of the elastic fibres or wires lining the clip, each side in descending grips the rod, F, firmly, and brings it down with it, while the opposite side in rising slips freely up the rod for a fresh grip. Thus the rod is carried steadily forward by the motion of B in either direction, each stroke advancing the carbon by about $\frac{1}{100}$ of an inch, or even less; and, in fact, the lamp may be adjusted so that the feed is imperceptible and continuous. The length of the arc may be varied within very wide limits by tightening or slackening the screw, J. The greater the tension of the spring, I, the longer will the shunt magnet be in coming into action, and the wider the arc maintained.

In the latest form of lamp the cap, E, has been replaced by a purse-clip arrangement, shown on plan, which is opened or closed by a cam, the lever of which passes through the wooden base, thus allowing the lamp to be trimmed without opening the cover. The arc is struck or the carbon separated by a small electro-magnet below the lower carbon, which presents some novel features.

From the above it will be seen that the Belfast lamp possesses some features of novelty, and appears to be distinguished by extreme simplicity of design and action, the working parts being few, with a noteworthy absence of any gearing or clockwork. The chief merits claimed for the lamp besides its simplicity and cheapness, are its easy and ready regulation for any arc required, its adaptability to any size of current, and its extremely low resistance. We are informed that it will work in any position, and, indeed, may be turned upside down, or kept swinging from one end of the room to the other, without in the least interfering with its action. This feature should make it particularly valuable for ships or locomotive head lights.

Besides this, the carbon rod being firmly held, and the feed motion being actuated only by a small portion of the main current diverted at intervals, there is an obvious saving in dispensing with a heavy solenoid which usually has to sustain the upper carbon rod and its attachments, sometimes the whole works of the lamp being carried by the action of the main current.

It is further stated that in practice a cut-out can be dispensed with in most cases, as there is no liability to any interruption; in fact, any small obstruction, such as grit or dirt, getting into the works (which is fatal to most lamps), either takes no effect upon this, or results, as the arc lengthens, in the power of the feeding action rising to force the carbon rod past the obstacle.

When we say that the price of the lamp, with a neat brass case, is only £5 5s., that its design is good, and the entire weight without the globe is only 11 lbs., it must be admitted that the Belfast Electric Appliances Company have succeeded in making a decided step in advance in the matter of arc lighting. These lamps can be obtained from the supply department of Messrs. Woodhouse and Rawson, 11, Queen Victoria Street.

Telegraphic Extension to Fishery Stations.—Some time ago the Scottish Fishery Board entered into communication with the Postmaster-General with the view of having telegraphic extension to a number of remote fishery districts, and we understand that arrangements have now been concluded under which such extension has been made to several of these places. These are Castle Bay, Barra; St. Margaret's Hope, Burra; St. Mary's, Orkney; Walls and Reawick, Shetland.

ELECTRIC LIGHTING IN THE NAVY.

THE Lords of the Admiralty arrived at Portsmouth last Monday to make their annual inspection.

The *Times*, in alluding to this visit, gives the following information respecting the work in hand at Portsmouth:—

The *Triumph* has undergone a thorough refit for a four years' commission. The armaments in the upper and lower batteries remain unchanged, but the 64-pounders on the quarterdeck and forecastle have been removed, and 50-pounder breechloading guns fitted, and in ports specially constructed for them. Ten Nordenfelt and four Gardner guns have been placed along the top of the nettings, and the latest devices for ejecting torpedoes have been added to the torpedo ports, with travellers, magazines, &c. New submarine mines and electric stores and a Nordenfelt magazine have been built during the refit. The *Triumph* has also been provided with the electric search light in two new positions, a D Gramme dynamo being used for the purpose. In the case of the *Bacchante*, as in that of many other ships, the principal work is to effect a change in her armament, and fit her with the electric light and a complement of machine guns. She was formerly fitted to fire Whitehead's torpedoes from six ports on the broadside forward and aft, and she is now being furnished with electrical machinery for search purposes. No date has been fixed for her completion, but she will be ready for sea within the current financial year.

Considerable progress has been made during the year at Portsmouth with the fitting of electric lights on the incandescent principle for the internal illumination both of armour-clads and troopships; and sufficient experience has been acquired to afford valuable information as to the most efficient dynamos in existence for the purpose. Enough, in fact, has been learned to demonstrate that the day of the arc lamp for internal illumination is past, although in the *Inflexible*, the first ship in which an installation was made, 33 Brush lamps of the kind, fed by a couple of Brush machines, are used for general lighting between decks, in the engine and boiler rooms, and in the fighting parts of the turret ship. The Edison system has since been introduced into four of the Indian troopships, and will be fitted to the *Euphrates* prior to her further employment. In these, however, the dynamos are of somewhat different types, but in all the Edison incandescent lamp has been adopted. With the exception of the *Serapis*, in which Gwynne's high-speed engines are used, Brotherhood's engines are employed for driving the generators. During the last trip of the *Crocodile* a comparison was made between the cost of electrical and candle illumination, and the difference was found to be 100 per cent. in favour of the former, besides its proved superiority in respect to the saving of labour and the reduction of heat, cleanliness, freedom of risk from fire, and brilliancy of light. After every allowance against the electric system has been made, it is evident that on the twofold ground of economy and efficiency its general application to the ships of the Navy is only a question of time. The torpedo ram *Polyphemus* has been provided with two of Siemens' dynamos worked by Brotherhood's engines. The lamps employed are Swan's; but, what is quite unique on board ship with regard to electric circuits, the single-wire system has been adopted, the return being completed by earth circuits. Another novelty has been fitted in leading the wires through iron tubes in the engine and boiler rooms, but experience can alone determine whether these innovations are improvements, the probability being that the balance of advantages will be found to remain with the ordinary methods. The complete installation consists of two arc search lights, 220 incandescent lamps for internal lighting, and a yard-arm reflector fitted with eight 50-candle power incandescent lamps. Each dynamo and engine is to be capable of giving an arc search light of not less than 25,000 candles, or 150 incandescent lamps of not less than 20 candles each. It will thus be seen that in this extraordinary vessel the electric light is to be applied not only for the internal illumination, but for searching—that is, for the purpose of throwing a powerful beam of light around the ship whereby a night attack by an enemy may be timely discovered and frustrated.

In the *Colossus* this double requirement of the service is met by the Brush Company's "Victoria" machine. Of these there are no fewer than three on board, every part of the ship being brilliantly lighted. In action, one of two dynamos will be able to feed the whole of the lamps in the citadel, platforms, engine and boiler rooms, magazine and shell rooms, and other essential parts. By these means the other machines can be simultaneously employed to produce search-lights at the fore and after ends of the ship. Usually it has been considered sufficient to supply one search-light at a time, as is the case in the *Dreadnought*, where a single "Victoria," driven by a Parsons engine, is carried. In the *Colossus* one of the machines may be regarded in a great measure as a reserve in the event of a breakdown at a critical moment, in which case even, the ship would be more efficiently served for domestic and search purposes than any other vessel in the service. As there was no time available for a complete installation on board the *Dreadnought*, it has been decided to use the Coulomb candle-lamps between decks during her forthcoming commission. The Victoria dynamos appear to be specially adapted for double requirement lighting, and, as far as experience has gone, the machine, which is compound wound, is by far the most promising of the types in use in the service. One of the same kind, but of smaller power, has been fitted in the *Dolphin* at Sheerness, with very satisfactory results, and several other ships of war are to be supplied with similar generators. The Brush Company has also its own incandescent lamp; but the differences between the best known descriptions are not great, no one kind appearing to possess any marked superiority over the rest. The *Bacchante* and *Triumph* have been fitted with the D Gramme machines for search-light purposes, but it is not probable that any more will be supplied, as they cannot be safely run for more than a few hours at a time on account of the heat developed, which has the effect of destroying the insulation and rendering the machines useless. The *Volage* has been fitted with Wilde's improved machine, which is certainly a great advance upon the earlier productions of the inventor. His machines at present, however, are no longer in the race, having been outstripped by later patterns. Still, much credit is due to Mr. Wilde as the undoubted pioneer of electric lighting on board ship. A very satisfactory trial of the installation on board the *Colossus* was made on Thursday and Friday last week. The dynamos were run consecutively for six hours each day at 400 revolutions a minute, and with a steam pressure of 40 lbs. The machines were loaded to 180 ampères, and exerted an electromotive force equal to 80 volts. The following table gives particulars of the several installations at Portsmouth :—

Ship's Name.	Dynamos.	Engine.	Lamps. Hlf. Whl.	Candle Power.
Crocodile ...	Edison-Hopkinson	Brotherhood	288— 96	10 & 16
Malabar ...	Edison	Do.	204—115	16 & 8
Serapis ...	Edison	Gwynne	299—101	16 & 10
Polyphemus	Siemens Comp'd...	Brotherhood	... —220	20
Colossus ...	Victoria	Do.	250—230	20 & 10

The Brotherhood engine is usually coupled with two dynamos, but whether it will maintain its supremacy is uncertain, as the experiments in electric lighting which have been carried out at Portsmouth for some time past, though hardly yet completed, have shown that other makers can produce as economical engines in regard to consumption of fuel, and which seem to combine peculiar advantages. Lengthened trials, however, are necessary to verify the *data* which have been obtained.

On Tuesday the Lords of the Admiralty visited the *Colossus*, which was brilliantly illuminated by the electric light, in order that their lordships might witness the perfection and beauty of the installation, the most noteworthy of any which has yet been carried out in the Navy, every compartment in the ship having its own lamps and switches. The general arrangement comprises a night and day circuit for the mess, decks, citadel, passages, and working parts of the vessel, while the stores and other smaller compartments have their own lights and switches. The night or police circuit consists of a few 20-candle-power lamps in low and prominent positions, placed so as to specially facilitate movement without oil lamps of any kind having to be carried. The lamps for the mess tables, officers' cabins, and general illumination are, on the other hand, of only 10 candle power. In the vicinity of the engines and lathes, and also of the amputation tables and sick bay, there are sockets at which, by the insertion of a plug, temporary connection is immediately made, whereby hand lamps fitted with long flexible cables can be placed in any required position. The whole of the fittings have been designed with a view to counteract the concussion produced by the firing of the heavy guns. With this view each lamp is provided with special spring sockets and flexible holder, as well as springs for the globe to rest upon. The switch board in the dynamo room has six main circuits, two leading to the projectors, a third to the forward part of the ship, on which there are about 90 10-candle power and 50 20-candle power lamps, a fourth to the after portion, where there are 55 10-candle power and 46 20-candle power lamps; while the others light the citadel, where there are 31 10-candle power and 13 20-candle power lamps, and the engine room, which has 68 of the smaller and 14 of the larger lamps. These mains are further subdivided by the switch previously mentioned, and also by a special arrangement of branch switches for the feeding of the magazine and other lamps that would be required during an engagement. At such time one dynamo would suffice to fully illuminate the entire ship, while a second could be used for the forward and aft projectors, the third (which completes the stock) being kept in reserve for emergencies. Each dynamo is coupled to one of Messrs. Brotherhood's direct-acting three-cylinder engines. The dynamo used as beforesaid is the one known as the "Victoria," which is of the compound-wound, self-regulating type, and is considered to be the most efficient of the many recent improvements in this line. From one lamp of ten candles to any number of lamps up to a total of 4,000 candles may be turned on or off by their own or the branch switches without making any difference in the brilliancy of the others or affecting the speed of the engine, or in any way altering the conditions under which the machinery is working, with this exception—that for every 240 candles turned on an additional horse-power is required. The old trouble of sparking brushes has also been entirely got rid of. The installation includes two yard-arm reflectors, each containing eight 40-candle lamps and having portable leads, so that the reflectors can be hoisted to any part of the ship for the purposes of coaling, loading &c. The connections for these are made at a terminal box on the superstructure. The projectors, of which there are three, are of the newest type. Each contains a lamp equal to 40,000-candle power, and will enable a boat to be discovered at a distance of eight miles, and its occupants to be distinguished at a distance of two-and-a-half miles. The whole of the machinery, lamps, and fittings have been supplied by the Anglo-American Brush Electric Light Corporation, and the installation has been carried out by a small staff of workmen from the same firm, under the superintendence of Mr. O. J. Williams. The work throughout, however, has been subject to the scrutiny of the Dockyard officials, who have expressed themselves highly pleased with the success attending it. Their lordships instituted a painstaking inspection of the entire system, the whole of the lamps being aglow, with the exception of the reflectors and projectors, the effect of which, being outside the vessel, would have been killed by the daylight. They visited the dynamo room and the various mains, and witnessed the lighting of the magazines and the other fighting parts of the ship. They were highly satisfied with the result, and there can be little doubt that the system will be applied to the other ships under construction. It was intended to light the ship for some days continuously, with the object of determining the amount of fuel consumed, and so arriving at the cost of lighting a ship of war by electricity as compared with the ordinary method.

REVIEW.

Les Accumulateurs Electriques et la Mécanique de l'Electrolyse. (*Electric Accumulators and the Mechanism of Electrolysis.*) By ALBERT BANDSEPT. Bruxelles: Verteneuil.

The author of this treatise sets out with a discussion which might well have been deferred to its conclusion —*i. e.*, the consideration of the industrial value of accumulators. He raises more especially the question whether we are justified in expecting results more satisfactory than those which have been hitherto obtained. The opinion is, it seems, very generally entertained that the reports already issued are sufficient to condemn accumulators as adapted neither for the electric light nor for the production of power either in the household or on tramways. This view, the author considers, is exaggerated. He considers that even if the yield of power should be inferior to what has been announced, there are many cases where the use of the accumulator would be justified, whilst in many others its intervention is simply indispensable. He shows that there are cases where a direct transmission of power would require so much capital to be sunk that the undertaking would prove commercially impracticable. Here, then, the accumulator steps in.

Further, all the applications of electricity require a regular current. But however much the original motive power may fluctuate, we may obtain a constant yield by the intervention of the accumulator. To give an instance: the arc light is often insupportable, as its brilliance fluctuates incessantly with the least variations of the supplying current. But the difficulty may be overcome by using the primary current to charge accumulators which then, in turn, feed the arc lights. Meantime various improvements are at least conceivable. It remains to be seen if the very moderate yield of accumulators with perforated plates may not be due to the insufficiency of the accumulating surface. If the chemical action remains the same, the yield ought to be a function of the quantity of the action. Hence it might be advantageous to augment the weight of accumulators in order to improve their yield. We must not, however, forget that this very weight is already one of the obstacles to the employment of secondary batteries. Unless the yield is increased in a higher ratio than the weight, there is little prospect in this direction.

The cases where accumulators may prove useful are summed up as follows :—Where a constant result has to be obtained from a fluctuating source of power; where the source is feeble, but by being stored up it may suffice to effect a considerable effort for a short time; and, lastly, where a great source of power is at present wasted on account of its sparing accessibility.

In the next chapter we find a discussion of the storing power of accumulators. The majority of the present accumulators being merely modifications of Planté's battery, the author inquires in how far its imperfections have thus been remedied.

One of the cardinal faults of the Planté battery is its tedious and delicate construction. Even after the lapse of months a certain portion of the metal remains unutilised, and merely adds to the weight of the element.

M. Faure has been more successful in the task of fixing the minimum upon the plates of lead. He has also sought to increase the storing capacity of the original apparatus, which was limited to the thickness of the plates of lead. It was supposed that the capacity of storage would be a function of the quantity of oxide of lead employed. But this principle was falsified by the extent which was given to it.

It is here remarked that an accumulator is a true electrolyte, the constituent elements of which appear principally on the surface of the plates. On penetrating into the substance of the electrodes these elements condense themselves, and give up the charges of electricity which they received on their decomposition. The electricity is thrown upon the conductive portion of the plates to pass then into the interior circuit of the battery. The constituents of the liquid traverse the surface of the electrodes the more easily the more it is porous, and the condensation of these elements is so much the more complete as these pores are close together.

Proceeding with his investigation, the author shows that M. Faure has solved only one of the conditions, and consequently the power of the apparatus remained substantially the same. What is gained in capacity in Faure's apparatus is lost in the prolongation of the charging.

It is suggested that a better yield might be obtained by combining the methods of formation of Planté and of Faure.

In the succeeding chapter, on the "Formation and Storage Capacity of Accumulators," we have an examination of the view that one accumulator is as good as any other. The author urges the importance of considering the accumulators not merely from the point of view of their absolute capacity, but from that of their relative power for a given time. This element has been hitherto too much left out of consideration. The power of an accumulator, he argues, depends essentially on the quantity of chemical action produced in a unit of time, and for a given weight of lead and of oxides.

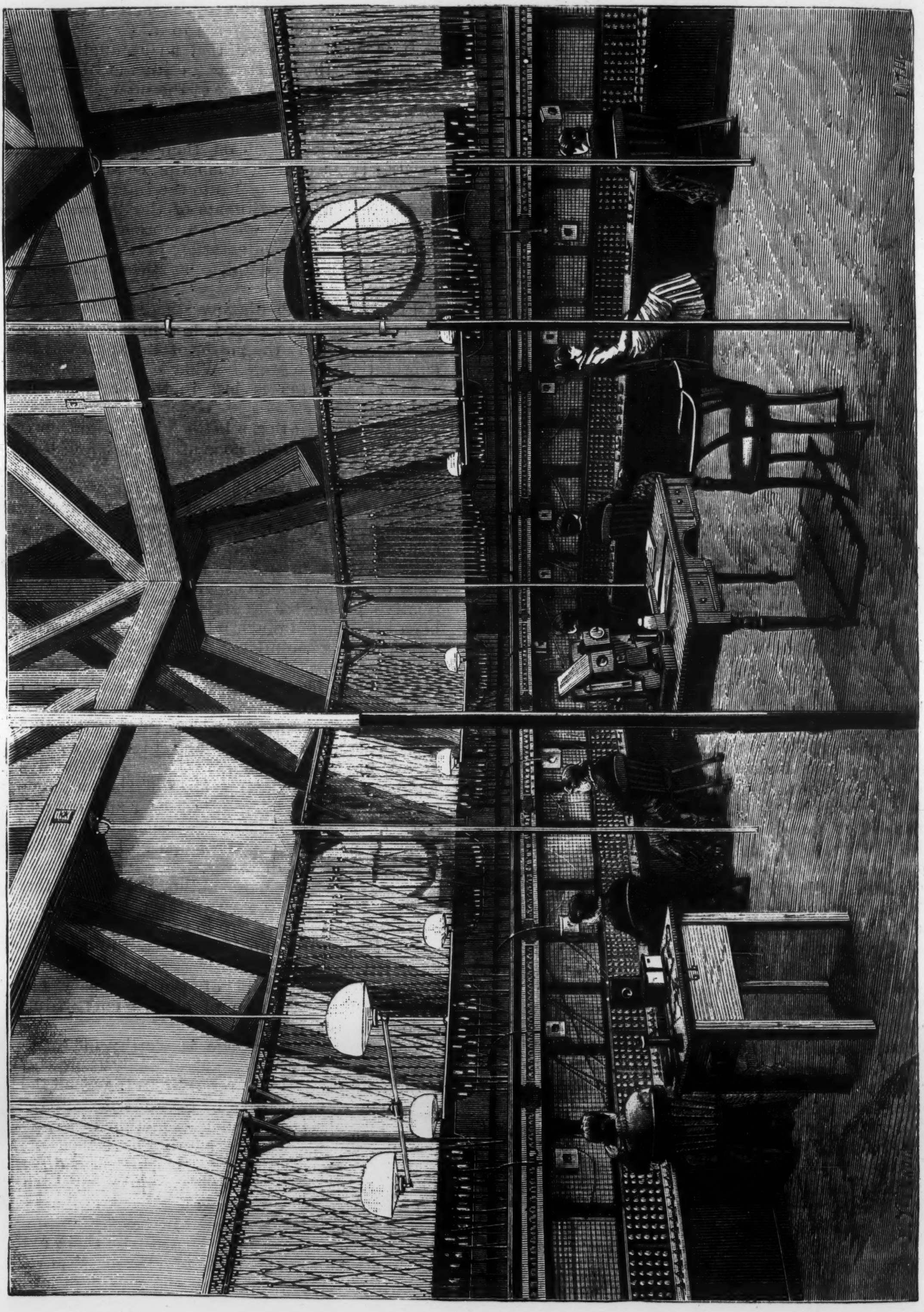
The succeeding chapters are devoted to secondary means for abridging the work of forming accumulators —at present too tedious—and to the recovery of the energy lost in the secondary effects of electrolysis. M. Bandsept reminds us that electrolysis is a phenomenon of dynamic electricity, of transfer and not an electrostatic effect. His view of the mechanism of electrolysis is given in a diagram, the import of which cannot be readily expressed in words.

In a final chapter the author points out that every battery in which the chemical action producing the current does not give rise to volatile products may constitute an accumulator if we cause it to be traversed by a current in the inverse direction to that which it produces. The principle of the secondary battery is therefore the absorption of electric energy during the decomposition of water.

The concluding passage is worthy of careful consideration :—"The mechanical analysis of the phenomenon of electrolysis, referred to the general laws of motion, and principally to that of rotation, is beyond doubt logical, because rotatory motion is so general in the universe that we must admit the existence of general causes, or of a physical law by which it is determined. There are no rectilinear motions in the universe; there are merely motions in broken lines, and their rapidity must naturally be accelerated in proportion to the condensation of masses and decrease by their extension. But the whole mechanism of electrolysis consists in expansions (partial decompositions, dissociation, absorption of thermic and electric charges); condensations (occlusion of gases, combination of elements with the polar materials), and in certain effects of connection which govern the transport of the current—all actions which may be summed up in certain combinations of mediate and immediate motions, reproducing themselves necessarily in all circumstances and everywhere."

THE "MULTIPLE" SWITCH BOARD.

THE directors of the Lancashire and Cheshire Telephonic Exchange Company, being desirous of affording their subscribers the benefit of the latest improvements, and to render their service as perfect as possible, have recently adopted in their Liverpool exchange the multiple switch board, described by the committee on central office systems, at the last American "Telephone Convention," as the nearest approach to a perfect system.



The multiple switch board in use in Liverpool is fitted for 1,000 subscribers, with an ultimate capacity of 2,500. It is in five sections, each section having annunciator drops for 200 subscribers, but spring-jacks, or connection points for 1,000, so that the operator at each section, whilst receiving the calls of only 200, is able to connect any two of the 1,000 subscribers, without moving from her place, and without communicating with any other operator. The connection is made by plugs and cords, in circuit with a special "clearing-out" drop, which is to receive the subscriber's signal to disconnect.

Each subscriber is represented by an annunciator drop in one of the sections of the switch board, but his wire, before going to the drop, passes through every section in the system, and at each one is intercepted by a spring-jack, so as to afford every operator in the switch room the opportunity to make connection with that wire. It is obvious that if this wire is always at the disposal of a number of operators, each of whom can connect on to it at pleasure, and who cannot stop to observe each other's motions, or look around the room to see if the wire is in use elsewhere, the operator must have a ready means of ascertaining whether any required line is already occupied at another section. This is accomplished very simply, by a signal given in the act of making the connection, which is heard in the operator's telephone the instant the plug touches the spring-jack of the subscriber. When this signal is heard, it indicates that the line is in use elsewhere, and the operator, therefore, does not complete the connection.

In order to provide for this signal, and bring every line in the system within the reach of all the operators, each wire must pass twice through every section in the switch board. The connecting wires are run in cables behind the board, and their number in a large exchange is necessarily enormous. The whole apparatus, with these numerous connections, is of course somewhat complicated, and requires care and skill in the mounting.

While, however, simplicity of construction is important in the instrument placed in a subscriber's office, in the exchange apparatus simplicity of operation is the important point. Here simplicity of construction may lead to complication in use, while complexity of construction is no drawback, so long as it leads to simplicity in use. So the multiple switch board, while somewhat complicated in construction, attains the great desiderata of a central office system—quickness and certainty in making connections, and economy of working force.

To show the economy of time effected by this system we need only to mention the method hitherto pursued, which has been to divide the subscribers among different switch boards, generally about 50 to each board, with a number of connecting wires or strips joining the different switch boards, each one of which required an operator. A subscriber, therefore, calling for some one at another board than his own, required the intervention of two operators; the first to receive his call and join his wire to a connecting strip, and the second to join that connecting strip at the second switch board to the wire called for; the connection order being conveyed from operator No. 1 to operator No. 2 either by word of mouth or by written ticket—the *viva voce* method leading to much noise and confusion; the ticket to long delays; and both to many mistakes, with the natural result of exasperating the long-suffering, but not very patient, subscriber.

The multiple system, on the other hand, gives each operator control of all the wires, thus reducing by one-half the work of making a connection; so that no word is spoken, no ticket written, and only one person called into requisition.

Our illustration, for which we are indebted to *La Lumière Electrique*, shows nearly the whole of the switch board, a small portion only being omitted on each side. The sections now in place form two sides of a square, on the other sides of which additional sections of 200 each will be added from time to time, as the subscribers increase in number. As new sections are fitted, additional spring-jacks will be placed in the present boards, in the blank spaces left for that purpose. The frame containing the clearing-out drops, at the top of the working parts, is movable and can be raised as the space is needed for spring-jacks. The system is thus adapted for a progressive growth up to its ultimate capacity of 2,500.

Each 100 spring-jacks are mounted upon a wooden strip, 15 × 5 inches, and each 25 annunciator drops occupy a space of $10\frac{1}{2} \times 8\frac{3}{4}$ inches. Each 200-wire section of the Liverpool switch board is therefore, with panels, &c., 7 feet 7 inches long. The table is 26 inches from the floor. The working parts are thus within convenient reach.

The length of each section affords ample room for the operators to work without crowding, and, in the event of a "rush," allows three operators to be placed at each section, although two operators for each 200 wires are found to be sufficient for ordinary requirements. The system is, however, adapted to meet the necessities of the severest strain, and is in use in at least one large exchange (Indianapolis, with about 1,200 subscribers) where the number of calls per subscriber reaches 10 per day.

In Liverpool the operating force has already been reduced by one-third, and the present number will not require to be increased until a large number of additional subscribers are connected. It appears that the saving effected by the company in the item of operators' wages will pay the entire cost of the switch board every three years.

The average time occupied in working is as follows:—Operator answers call in 5 seconds; puts to, through, and calls wanted subscriber in 9 seconds; connection completed between two subscribers in 14 seconds from the time the calling subscriber touches his bell.

The daily average number of calls per subscriber is six, so that, with 900 subscribers, there are about 5,400 telephonic conversations in Liverpool every day.

As all of the 900 subscribers are connected to a single central office, the registered number of calls does not represent two or three times the actual number of conversations, as it does in some exchanges, where the subscribers are divided up among several small branch offices, and every "ring up" on a trunk line is counted as a "call."

Liverpool is the first city in the United Kingdom to adopt the multiple system, which, however, is in use in two cities on the Continent—Budapest and Gothenburg—and in Melbourne. In America it has been adopted by about 20 of the largest cities—New York, Boston, New Orleans, Baltimore, Washington, Milwaukee, Indianapolis, Toledo, Lousville, &c.

The manager of the Liverpool exchange, Mr. Claxton, and the electrician, Mr. Haworth, are to be complimented upon the admirable arrangement of their entire system, as now established. There is a most striking contrast between the present neat and orderly appearance of the switch room, with the quiet, steady work of the operators, and the former condition of the same place, with its medley of divers sorts of switch boards, and the noise, confusion and screaming of the operators, ineffectually attempting to keep pace with the demands of the subscribers.

The multiple switch boards are manufactured by the Western Electric Company, of Chicago, New York, Boston, and 59, Moorgate Street, London, who are the holders of the patents covering the entire system.

Companhia de Telegraphos Urbanos. Escriptoric Central, 31, Rua do Hospicio. Serviço Telephonico. Lista dos Assignantes, No. 8, Rio de Janeiro: Typographia Universal de H. Laemmert & Co., 1884.—We have here a prospectus of the Urban Telegraph and Telephone Company of Rio de Janeiro. The company, it appears, was created by Imperial decrees of 1880, 1881, and 1882, and extends its operations to Corte, Nitherohy, Petropolis, and San Paulo. The pamphlet before us is a monthly publication, showing the telephonic stations, and giving a directory of subscribers. There is firstly an alphabetical list; then a catalogue arranged according to trades or professions; and then a street directory. Next follows a list of the subscribers arranged according to their numbers, and lastly is an enumeration of those firms, &c., who have private lines. The total number of subscribers exceeds 5,000. Hence it would appear that telephonic communication must find considerable favour in the Brazilian capital.

NOTES.

Electric Lighting.—Trials have been made at the Collége Sainte-Barbe and the Lycée Louis-le-Grand, Paris, under the superintendence of the architects, with a view to the adoption of Edison incandescent lamps with frosted globes for the lighting of the class rooms.

At the exhibition lately held in San Francisco, the Thomson-Houston Electric Company was awarded the first gold medal, and the Brush Electric Company the second.

The Blackpool Municipal Authorities have, we learn, discarded the electric light, mainly on the ground of expense. Some members desired that the light should be continued on certain nights in the week, but it was stated that it cost considerably over £1 per night.

The Brush Electric Light Company, of Rochester, N.Y., has in use 1,100-H.P. from the Genesee Falls, which it owns, and is now putting in wheels for 700 more H.P. It proposes to rent the additional power for manufacturing purposes. The company is now running 500 Brush arc lights.

The ss. *Olympo*, built for the Messageries Fluviles de Vapor of Buenos Ayres, made her trial trip last week on the Clyde. The vessel is intended chiefly for the mail service between Buenos Ayres, Monte Video, and the Rio Parana. The electric light has been fitted throughout the steamer by Messrs. Harvie, of Glasgow, and has been pronounced one of the most complete installations ever put on board a steamer.

Several large ships were launched on the Clyde last week, every one of which is to be provided with the electric light.

An Art Loan Exhibition was held last week in connection with the Mechanics' Institute at Llanelly. The lighting of the hall by electricity was effectively carried out under the superintendence of Mr. J. C. Howell, a Crompton-Bürgin dynamo supplying current for 34 incandescent lights. The exhibition included a variety of electrical machinery and appliances, amongst which were specimens of Mr. Tayler Smith's electrical fittings.

The cost of the maintenance of the electric light in the Forestry Exhibition, Edinburgh, which has just closed, is said to have been about £1,500.

The old Theatre Royal, Liverpool, is about to be converted into a circus, and the necessary alterations for it are being rapidly pushed forward. The entire building, both outside and in, is to be lighted by electricity, the order for which has been placed in the hands of Mr. F. D'A. Goold, Manchester.

The Edison and Swan United Electric Light Company is lighting the new Cannon Street Station of the Inner Circle Railway. The installation consists of an Edison "L" dynamo, driven by a Marshall portable engine, placed on Dowgate Hill. The number of lamps is 80, about 30 of which will be of 30 to 40-candle power, according to requirements. The lighting at this station is in a measure experimental, and if the results are satisfactory it is intended to light the remainder of the new stations in a similar manner.

The Sault Canal, Canada, is illuminated by electricity. The power is generated by a turbine water wheel, which supplies power by hydraulic machinery to run capstans and to open and shut the gates. It is automatic all through, and the pressure is constant. As soon as the pressure is reduced, the pumps start to make up the supply.

There can be no doubt, says the *Mechanical World*, that substantial progress is being made in electric lighting. On all hands we hear of new and successful installations and of satisfactory improvements in the plant. If the makers of incandescent lamps would be satisfied with 100 per cent. profit on their manufacture, instead of extorting 750 per cent. profit, the progress would be still more rapid. It is satisfactory to find that the clumsy and ignorant muddlers who formerly assumed a monopoly of electric lighting are being displaced by a better class of men.

The Corporation of Manchester has placed the contract for the lighting of the New Victoria Hotel in the hands of Mr. F. D'A. Goold. This is to be one of the most perfectly-fitted hotels in England, and it speaks well for the progress of the electric light that a large Corporation like that of Manchester, which owns the gas works, should turn to the rival illuminant to obtain the perfection which it is desired to have in the above hotel. We understand that business in this part of the country is remarkably good, and promises to improve rapidly.

A Telephone Cable.—The Sunset Telephone Company, of California, is using an A. G. Day kerite cable, 10,000 feet long, across the Golden Gate, from Fort Point to Lime Point, in connection with a telephone line 65 miles long. The service is stated to be excellent.

The Telephone in Sheffield.—We learn that negotiations are going on between the Postmaster-General and the Sheffield Telephone Exchange Company, which will bring about alterations of an important character. The tariff is to be re-arranged and considerably reduced. Call offices will be opened in various parts of Sheffield, to which the public may be admitted to speak to any of the subscribers on payment of a small fee; and Sheffield is to be placed in telephonic communication with the neighbouring towns.

Telephones on the Underground Railway.—For the better working of the signalling system on the newly-completed Inner Circle Railway, a continuous line of telephones between the various signal boxes has been established, which has already been of considerable service in allowing signal men on various portions of the line to communicate by word of mouth.

The Multiple Telephone Switch-Boards.—Says an exchange: John J. Carty, in charge of the operating-room of the Boston Telephone Exchange, has returned from an extended visit to Chicago, where he inspected the new multiple switch-boards for his use, in process of manufacture by the Western Electric Company. He reports that when completed and in operating order the system will surpass any in use.

The New York and New Jersey Telephone Company.—A volume of some bulk has been forwarded to us by Mr. W. D. Sargent, the general manager of this company, containing a list of subscribers in the various towns reached by the company's lines. This shows a very extended use of the system in the neighbouring states of New York and New Jersey. Call offices, or "pay stations," are also numerous.

Proposed Atlantic Telephone Cable.—A telephone line across the Altantic Ocean is confidently spoken of. The first experiment in submarine telephoning, it is said, will be made between Halifax, Nova Scotia, and Gloucester, Massachusetts, a distance of 850 miles.

Cable Repairs.—The Eastern Telegraph Company notifies the repair of the Haiphong-Hong-Kong cable, thus restoring telegraphic communication *viâ* India with Hong-Kong, Manila, Macao, Shanghai, and other places in China.

New Submarine Telegraph Cable.—We are informed that on the 9th inst. the ss. *International*, of the Silvertown Telegraph Works, completed the laying of a cable connecting St. Vincent with St. Jago, Cape de Verde Islands.

The Soudan Telegraphs.—A telegram from Wady Halfa, dated October 9th, stated that a cable was being laid to the telegraph office on the other side of the Nile. It was expected that this would greatly facilitate the despatch of messages.

Telegraphic communication beyond Assouan was again interrupted on the 14th inst.

The Mackay-Bennett Cables.—The completion of the second Mackay-Bennett cable, a daily paper states, had the effect of making Anglo-American Telegraph Stocks flat.

Telegraphy in Australia.—In 1883, the extent of electric telegraph wire in actual use in New South Wales was 17,272 miles, 41 chains, 35 links; the number of stations, 368; the revenue, £134,643 2s. 4d.; and the expenditure (exclusive of interest on cost of construction of lines), £163,328 16s. 11d. 2,107,288 telegrams, of the value of £165,276 14s. 10d., were transmitted from the Colony; and 2,102,044 telegrams, of the value of £159,095 2s. 1d., were issued in the Colony. The New South Wales receipts on local and intercolonial (exclusive of New Zealand) business were £122,891 0s. 7d.; on New Zealand business, £1,898 15s. 1d; and on international business, £3,049, making the total receipts £127,838 15s. 8d.

Telegraphy in Ceylon.—The telegraph department of Ceylon, according to the *Colonies and India*, though useful, has not proved productive. Hopes are entertained, however, of its final success in a financial sense.

The Value of Telegraphy in Naval Warfare.—The *Times* correspondent at Shanghai states that one of the lessons taught by the engagement between the French and the Chinese on the Min is the value of the admirable electrical apparatus for telegraphy, used nightly. This and other points, he says, deserve the serious attention of our naval and military authorities.

Sixpenny Telegrams.—Four new wires are being added to the west coast system between England and Glasgow in anticipation of the increased business when the sixpenny rate for telegrams comes into operation.

Telegraph Revenue.—The total receipts upon the telegraph service from April 1st to October 11th, 1884, were £925,000, against £1,000,000 from April 1st to October 13th, 1883.

Telegraphic Communication between England and Scotland. — The means of communication between England and Glasgow by the west coast route have, we learn, been more than doubled during the last three or four years.

The Dangers of Electric Lighting. — A curious example of the safety as well as the danger of electric wires is reported from New York. An inspector employed by one of the electric light companies, while adjusting a lamp, received a shock, which caused him to release his hold, and he fell to the ground fracturing his skull. On the same day a boy, seven years of age, fell from the roof of a six-storey building and lodged on the wires of a lofty pole line. Having fallen but about 10 feet he was able to cling tightly to the wires, and remained suspended 50 feet from the ground until he was rescued.

Dr. W. H. Stone supplements the letter of Mr. Crompton to the *Times*, published in our last issue, in reference to the recent fatal accident at the Health Exhibition, by saying:—"It would be matter of serious regret if prejudice or panic were to interfere with the progress of electric lighting. But a totally new industry and a new industrial change has arisen in our midst. This requires new precautions. The proximate cause of death in many of these accidents seems still physiologically somewhat doubtful, and it has hitherto been difficult to obtain precise details as to symptoms and appearances after death. No doubt 'shock' is responsible for many, as in the older case of lightning. But both catalytic action and the thrombosis of large vessels, which Virchow has brought home to us, are also possible, and, I believe, do occur. I have been for some time endeavouring to give the subject the careful investigation, both in a physical and physiological point of view, which it clearly requires."

The Distribution of Electrical Energy.—Some trials of the distribution of the electric light at a long distance have been made at Turin and Lanzo, and M. Tresca has been directed by his colleagues of the jury of the exhibition to bring to the knowledge of the Academie des Sciences the following facts:—Messrs. Gaulard and Gibbs have established between the exhibition, the station at Lanzo, and the intermediate stations a circuit, the total length of which, including the return, is 80 kilometres; the wire is of chrome bronze, 3·7 mm. in diameter, and uncovered. This wire is intended for the alternating current produced by a Siemens dynamo of the 30-H.P. type; the current may be used simultaneously for various modes of lighting, either at the exhibition itself, at the station at Turin, at the terminal station at Lanzo, or at any of the intermediate stations, by means of secondary generators of novel construction, exhibited by Messrs. Gaulard and Gibbs. "We proved, on the 25th ult.," says M. Tresca, "its satisfactory working: 1. At the exhibition, with the following apparatus, which must necessarily be supplied with very different potentials: 9 Bernstein lamps, 1 lampe Soleil, 1 Siemens lamp, 9 Swan lamps, and 5 other Bernstein lamps at a short distance. 2. At the station at Turin-Lanzo, 10 kilometres distant, 34 Edison 16-candle power lamps, 48 8-candle power, and one Siemens arc lamp. On the 29th the experiment was more conclusive still; the system being completed to the station at Lanzo, 40 kilometres distant, by the absolutely regular working of 24 Swan lamps of 100 volts. The many transformations required by the variety of methods of lighting were performed with safety; and although we are not yet in a position to give the exact figures, it is satisfactorily established that secondary generators should, at least within certain limits, give a relatively large rendering. Lighting and extinguishing is done without any disburbance, by means of simple commutators. The principal object of this communication is to prove the complete success of the distribution of various modes of lighting over an effective distance of 40 kilometres."

We do not see that M. Tresca's communication places any better appearance on the performance of the Gaulard-Gibbs apparatus than do the facts with which we are already so well acquainted. What we require to be satisfactorily proved is whether these transformers can be employed with absolute safety so far as their manipulation is concerned, and whether they are sufficiently economical to allow of serious thoughts as to their general adoption.

Charge against Directors.—At the Guildhall Police Court, on Wednesday week, Messrs. Dilwyn Parrish, Alfred Parrish, and John Goddard, jun., were summoned on the ground that the Union Electric Light and Power Company, Limited, of which they are directors, did not have its name painted or affixed on the outside of the office in which its business was carried on. Mr. Andrew Hutton, of 94, West Hill, Sydenham, and 2, Copthall Buildings, said he was a holder of 10 shares of £100 each in the Union Electric Light and Power Company. He had had disputes with the directors, and was dissatisfied with the way the business was transacted. He wanted some information and went to St. Stephen's Chambers, Telegraph Street, in September, 1883. There he found an empty room. There were some old books. The secretary was not there. In consequence of not getting the information there he went to Copthall Buildings. Mr. Bauer said he should be able to show that the defendants were only the liquidators. This matter occurred two years ago, and the complainant had an office at the very place where one of the defendants carried on business. Mr. Alderman Waterlow pointed out that there was an inaccuracy in the summons, and on that ground he must dismiss it. Mr. Wills asked for a fresh summons. He said his client was anxious to know where his £1,000 had gone. If he could get this information the Court would hear no more of the case. Ultimately it was arranged that other summonses should be issued, returnable on the 22nd inst.

The Western Union Telegraph Company.—Speaking of American commercial matters, the *Financial News* says :—"The one enterprise which, though controlled by Jay Gould, still maintains an appearance of respectability is the Western Union Telegraph Company. It continues to pay 7 per cent. dividends, and, according to the quarterly statement just issued, it has earned during the past three months $206,000 over and above all fixed charges, and carries that amount forward after disbursing $1,400,000 for dividends. It is quite clear, however, that American investors have no confidence in these figures ; if they had the stock would not be selling, as it is, in the neighbourhood of 60. They have a shrewd suspicion that Mr. Gould is cooking accounts and paying unearned dividends in order to induce them to relieve him of his stock, as he did in the case of Wabash. This suspicion is probably well founded. Western Union is Mr. Gould's last card, and he will naturally make the most of it. If he had succeeded in his attempt to obtain an official quotation for it on the London Stock Exchange—which, fortunately for English investors, he did not—he would probably have disposed of his holdings long ago. The recent combination of all the other telegraph lines in the United States against the Western Union does not augur well for the future of Mr. Gould's enterprise, and his action in appointing his son vice-president of the line seems to indicate that there is to be a new deal—of course in Mr. Gould's own interest."

Mr. Holroyd Smith's Electric Car.—Last week the members of the Manchester Association of Employers and Foremen made an inspection of the new electric tramcar and line which has been constructed by Mr. Holroyd Smith, of Halifax, and put down experimentally in an open field in the outskirts of Manchester. The whole arrangement of the car and tram line was generally commended by the members as one likely to open the way for a simple and practicable application of electricity to tramway traffic.

The American Underground Bill.—It has been decided by Judge Van Brunt, of the New York Supreme Court, that telegraph companies have had no valid rights for the erection of poles in the streets, excepting where compensation had been made to the owners of property in front of which they were erected.

The Bell-Drawbaugh Suit.—New York papers to hand record the continuation at length of Counsel's arguments for and against the above suit upon evidence with which our readers are familiar. A New York contemporary says that, whatever may be the decision of Judge Wallace, the case will be carried to the Supreme Court of the United States, and several years may elapse before it is finally terminated.

Technical Electricity at Owen's College.—The class in technical electricity, under the direction of Professor A. Schuster, F.R.S., commenced its third session last Thursday evening (October 16th). The class meets for two hours ; one hour being devoted to lecture, and one hour to laboratory work. The lectures deal with the leading scientific principles of electricity and their direct technical applications In the laboratory elementary students commence with the construction of a mirror galvanometer, a Wheatstone bridge, a standard resistance coil, and a Daniell's cell. All materials being provided, the student is required to put them together and to work simple tests with the constructed apparatus. Afterwards the student proceeds to a course of electrical measurements with the apparatus provided in the physical laboratory. This course includes testing for faults and the chief measurements relating to the strong currents used in electric lighting. Arrangements, also, will be made this session so that former and advanced students may devote nearly the whole of their time to work in the laboratory, which will be occasionally supplemented by short special lectures relating to practical work.

Aurora.—Last week, at Kirkwall, brilliant displays of aurora borealis were witnessed, and on Friday a violent thunderstorm broke over that town.

Lightning Conductors.—The sum of £900 is asked for lightning conductors for the Navy ; whether it has been allowed by the Lords of the Admiralty has yet to appear.

The Philadelphia Electrical Exhibition.—The International Electrical Exhibition at Philadelphia closed last Saturday night. It was highly successful, and the receipts largely exceeded the expenses.

Belfast Electric Appliances Company, Limited.—This company has issued a new price list for Empire carbons for electric lighting purposes, and draws attention specially to its cored carbons, which are confidently recommended for the pleasant white light emitted, and their good arcing qualities.

The Approaching Telegraph Conference.—Mr. H. E. Meyer wrote to the *Times* last week stating that at the telegraph conference to be held at St. Petersburg early next year a strong effort is to be made by the cable companies to reduce the limit for code words from ten letters to eight. He estimated this alteration, if passed, to be equivalent to an increase of 25 per cent. in rates. He had heard, also, of other proposals, all in the direction of limiting the use of telegraphic codes, and consequently increasing the cost of telegraphing. Mr. Meyer suggested that those interested should move in the matter at once in order to prevent any needless changes in existing regulations affecting the codes now used.

Mr. Lewis Wells, secretary to the joint committee of the Submarine Cable Administrations, contradicted the above statement, and said it was not intended to propose any alteration of the present rules which would have the effect of enhancing the cost of telegrams.

J. H. H., in a letter to the *Times* upon the same subject, says : "The Australasian people have a far more serious question to bring forward at the forthcoming Telegraph Convention than that complained of by your correspondent. The cost of a cable message from London to Australia varies from 10s. 8d. to 10s. 10d. per word, no reduction having been made to the public from the date of opening, more than twelve years ago. The newspaper proprietors of Australia pay £20,000 a year for Press cable messages, and the general public pay over £200,000 a year for ordinary messages. For Press messages the price is 6s. 5d. per word to Adelaide, but this is prohibitory unless for newspaper syndicates. My belief is that if a very important reduction is not made at the forthcoming convention in the cost of cable messages to Australia the Australasian Governments will construct at their joint expense an independent cable to Australia. In the correspondence before me, but not yet published, I find that those who own the cable and land lines from England to Australia have invariably answered our protests by saying 'We cannot make any arrangements because we are bound by the terms of the convention.' Therefore the necessity of taking action at the sittings of the convention. The Australian Governments now pay mail steamers large subsidies, and it is contended that the time has arrived to abandon these subsidies and to subsidise the cable companies."

Sir James Anderson, replying to this letter, pointed out the difficulties in the way of laying a cable by the Cape to Australia, and said the allegation that the Press was spending £20,000 per annum was true in 1878, but in 1879 the tariff was reduced from 10s. 8d. to 6s. 5d. per word, the result being a falling off of more than 50 per cent. in the number of words. The traffic, however, gradually increased, until, in 1883, there was an increase of 11 per cent. in the number of words transmitted, but a loss of £6,000 of revenue as compared with 1878.

Overhead Wires and Local Authorities.—At a recent meeting of the Metropolitan Board of Works, a letter from the Plumstead District Board was read, with which was a copy of a letter addressed to the Home Secretary, urging the importance of a Bill being introduced in the next session of Parliament conferring upon local authorities more complete control over overhead telegraph and telephone wires, and asking the Metropolitan Board to use its influence to secure such legislation. The communication was referred to a committee.

Experiment with Electrical Tramways.—In order to test the applicability of electricity to street tramway traffic, an experiment was made last Saturday morning on the lines of the Edinburgh Tramway Company, between the main entrance to ths Forestry Exhibition and the Haymarket Railway Station. The electric motor which has been in use in the car within the Exhibition grounds was placed in one of the ordinary cars of the Tramway Company. From the nature of the Tramway Company's lines, the current of electricity generated in the dynamo was not conducted to the rails, but to two lines of copper plate, placed on wood in the middle of the tramway line. The tramway car was connected with those copper plates by a small wheel and a metal cable. For this experiment those copper plates were laid down along the line of travel on the surface of the ground; but in any permanent system they would be laid underground. With one car, containing nearly a dozen gentlemen, two journeys were made from the Exhibition to the Haymarket Railway Station and back. The first, in which there were one or two stoppages, was accomplished at a speed quite equal to that which is attained on the level road by horse-power. It was not considered so successful as an experiment as the second journey, which, with only two stoppages, was accomplished very satisfactorily. The return from Haymarket to the Exhibition was made at a speed somewhat higher than is attained under the present system on a clear level line. An attempt was next made to run two cars by coupling the second to the one in which the electric motor was placed. This trial was not so successful as the others; but a portion of the road was run over, at, however, as had been expected, a lower, though not a greatly lower, rate of speed. The experiments were regarded with interest, and, so far as the results with the single cars are concerned, seemed to be as successful as the promoters had expected. Mr. Binko conducted the operations.—*Scotsman.*

A New Form of Relay.—A correspondent of the New York *Electrician* briefly describes a form of relay which the inventor claims will stand upon the same adjustment, under all changes of current from a battery of five cells or 50, because, as he says:—"My armature, contrary to the ordinary arrangement, starts at the point of maximum power, and moves farther away from this, instead of toward it, from a weaker field." He accomplishes this by adjusting his armature between the coils, opposite the face, and moving it toward the heel of the magnet, and of course the farther it travels in that direction the less the magnetic force exerted upon it.

Binko's Electric Railway.—The affairs of Mr. Henry Boch Binko, described as a chemical manufacturer, are undergoing investigation in the London Bankruptcy Court. From what transpired at the first meeting of the creditors, it seems that the electric train which Mr. Binko has recently been running at the Edinburgh Forestry Exhibition, had been seized under execution by Messrs. Dyson and Son, who had thereafter hired it to the debtor for 13 weeks, at a rental of £650.

The Jablochkoff Electric Light Company, Limited.—We hear that the date for the receipt of tenders for this company's plant and patents has been extended to October the 25th. If this is so, why has no public notification been made of such extension?

New Catalogue.—The price list issued at a charge of one shilling by the enterprising firm of Paterson and Cooper is unique in its character, giving as it does information of a practical and valuable kind respecting the variety of machinery and appliances which it illustrates. We advise electrical engineers and others interested in electric lighting, &c., to procure a copy, being assured that they will find it extremely useful.

Transfer of Business.—We hear that the Signal Engineering Company, of 181, High Holborn, has been bought by Messrs. Gillett and Harry, who intend carrying on the business of electrical engineers at the above address.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cordner, Allen and Company.—This company has entered into an agreement (dated 15th July) for the issue to Mr. William James Cordner of £8,000 in fully paid shares, and to Mr. Percy Ruskin Allen of £2,000 in fully paid shares, as consideration for the business taken over by the company in pursuance of the memorandum of Association.

CITY NOTES, REPORTS, MEETINGS, &c.

The London and Globe Telephone and Maintenance Company, Limited.

RECENTLY Messrs. W. Gutteridge & Co. published a circular in which the position of the above company as a promising concern was strongly urged, the following statements being made:—

The United Telephone Company in June last took over all the rights and interests of the Globe Company for a consideration of £25,000 in cash and a participation to the extent of three-eighths of all profits derived by the United Telephone Company on their provincial business, and also upon concessions to subsidiary undertakings. This arrangement was made prior to the removal of restrictions on the part of the Government, and the writers said they had authority for stating that a very large consideration, in the form of fully paid United Telephone shares had been offered to the Globe to cancel the agreement. Whereas the £1 shares of the latter were only 4s. 6d., the £5 fully paid shares of the United were worth £13¾, an exceptional opportunity being thus offered for purchases.

The issue of this circular was followed by a letter to the daily papers from Mr. Blaikie, secretary of the United Telephone Company, asserting that the statements therein contained concerning the latter company's arrangements with the Globe Company were erroneous, and calculated to mislead the public. To this Messrs. Gutteridge replied, remarking that Mr. Blaikie had not pointed out in what respect their statements were incorrect. They continued:—

"We have not made any statements upon our own responsibility, but mainly based upon the signed agreement between the companies. The document speaks for itself, and if the directors of the United Company object to the statement in our report respecting the offer of fully paid shares, can they deny that an offer equivalent to £50,000 was made to the Globe Company to cancel the agreement, and refused?"

Mr. Blaikie's reply to this was as follows:—

"I beg to deny most explicitly that the United Telephone Company, or any one acting on their behalf, have made any offer whatever, either of £50,000 or of any other consideration, to the Globe Company to cancel the agreement with them. With regard to the rest of Messrs. W. Gutteridge & Co.'s letter, I need only call attention to the statement in their advertisement, that the Globe Company are entitled to 'a participation to the extent of three-eights of all profits derived by the United Telephone Company on their provincial business, and also upon concessions to subsidiary undertakings.' This statement is properly characterised as erroneous and calculated to mislead the public, the Globe Company not being entitled to any such participation. What the Globe Company are entitled to is plainly set out in the agreement."

As considerable doubt seems to exist as to the terms of the agreement between the United Company and the London and Globe Company, we herewith give the substance of that document:—

1. The London and Globe Company assign and transfer to the United Company all exchanges, instruments, poles, wires, and other plant or apparatus; also all letters patent or patent rights for the United Kingdom, together with all contracts. This assignment does not include the license from the Postmaster-General, or any contract of employment of any officer of the company.

2. The United Company hold the London and Globe Company harmless in respect of all breaches of contracts so transferred.

3. The United Company undertake not to bring any action in respect of the instruments mentioned in Schedule 1 (about 30 transmitters and 110 receivers, sold by the London and Globe Company to purchasers to whom they have given indemnities).

4. The United Company do not engage to indemnify the London and Globe Company in respect of any wrongful acts done by them.

5. The United Company undertake to pay to the London and Globe Company £25,000 in cash, as follows:—£5,000 on execution of agreement, £10,000 within one month, and £10,000 within two months of such execution.

6. The United Company to enter into an agreement with the new companies to be formed for the purpose of working the business of a telephone company in certain districts specified in Schedule 2; such new companies to have a capital consisting of shares divided into 6 per cent. preference shares, with cumulative dividends, and ordinary shares, of which a portion not exceeding one-half may, if needful for the formation of the company, be appropriated to the holders of the preference shares, or the persons engaged in the formation of the company; such ordinary shares as remain after such appropriation to be divided between the United Company and the London and Globe Company in the proportions of $\frac{5}{8}$ and $\frac{3}{8}$ respectively.

7. The United Company to be entitled to stipulate that, as part of the consideration for such agreements, the companies to be formed shall pay a sum in cash in addition to ordinary shares, to reimburse any outlay of the United Company within the districts in which such companies are to carry on business.

8. If the United Company receive any cash or shares other than those referred to, they are to be divided in the proportion of $\frac{5}{8}$ to $\frac{3}{8}$.

9. Should the United Company elect to take preference shares in any company so formed, such shares to be divided in the proportion of 5 to 3.

10. The London and Globe Company shall submit to judgment with costs in the action now pending in respect to Hunning's transmitter, and shall also forthwith obtain the dismissal, with costs, of the appeal to the House of Lords in the action in respect to the Bell patent; the London and Globe Company agreeing further to pay the costs in the action with respect to the Blake patent, and to take no further steps therein. Provided always that the costs in the action referred to in this clause, including the appeal to the House of Lords, which are to be paid by the London and Globe Company, shall not exceed £400 altogether, and shall be submitted to taxation.

11. The United Company agree not to require payment of the balance of the costs in the action of Harrison Cox-Walker & Company, of the costs in the High Court of Justice, or of the costs in the Court of Appeal, provided that Harrison, Cox-Walker and Company execute within one month of date, and undertake to abandon in future all business in infringement of the United Company's patent rights, and to deliver up to the United Company all telephones, whether transmitters or receivers, belonging to them, or under their control.

12. All the litigation between the companies to be stayed on terms of each party paying its own costs.

13. With respect to the actions now pending against the London and Globe Company by other parties, a list to be submitted to the United Company within ten days of the execution of the agreement. If the United Company elect to defend any such actions, they shall be at liberty to do so in the name of the London and Globe Company by giving a proper indemnity to that company, who must hand over all papers in such actions free of cost.

14. The London and Globe Company undertake not to engage in any telephone business in the United Kingdom, except under the license of the United Company, and to surrender the license granted by the Postmaster-General.

15. In case the United Company desire that any agreement which by the terms of the contract is to be transferred to them, should be put an end to, the London and Globe Company shall, on request of the United Company, and upon being properly indemnified by them, take such steps as the United Company may desire to terminate the same.

16. Any difference between the parties to be referred to Mr. J. F. Moulton, as absolute arbitrator.

17. The agreement conditional on the consent of the shareholders of the London and Globe Company being obtained in general meeting within one calendar month from date.

The districts mentioned as included in Schedule 2 are as follows:—The whole of the counties of Norfolk, Suffolk, and Cambridge, and such part of the county of Essex as lies outside the circle, the centre of which is the General Post Office, and the radius 12 miles; the counties of Northampton, Huntingdon, Bedford, Buckingham, Oxford, Berks, and such parts of Middlesex and Hertford as lie outside the above-mentioned circle; the counties of Sussex, and such parts of the counties of Kent and Surrey as lie outside the above-mentioned circle; also, in the events hereinafter specified, the following districts:—Lincolnshire, Rutlandshire, in case those counties are not, by arrangements now pending, allotted to the National Telephone Company within six months of date; the West of England and South Wales district, including the counties of Cornwall, Devon, Somerset, Dorset, Wilts, Hants (with the Isle of Wight), Gloucester, Hereford, Monmouth, Radnor, Brecon, Glamorgan, Carmarthen, Cardigan, and Pembroke, in the event of arrangements now pending for the formation of a subsidiary company in this district not being definitely concluded within six months of date; such portions of the counties of Salop, Warwick, and Worcester as are not included in the district of the National Telephone Company, in the event of the same not being allotted to the National Company or the Lancashire and Cheshire Company under agreement now pending, or to the subsidiary company now in course of formation in the West of England and South Wales district, within six calendar months of date.

[It is clear from the above that the Globe Company has been absorbed by the United Company, so far as its interests in this kingdom are concerned; and the amount of £25,000 is no more than will pay the debts and debentures outstanding, and maintain on a small scale the organisation necessary to the selling of its foreign patents. Probably nothing will be left to the shareholders, as there can be no return of capital out of this £25,000, and the value of its present shares will depend, of course, on the value of its interests acquired by the agreement in the sub-companies to be organised. Now, as these sub-companies may, and probably will, operate in the most unimportant only of these districts, no comparison can be made of the value of the shares thus acquired with the value of the shares of the sub-companies already organised. Even these latter have, we believe, up to the present time, made no return to the United Company, although they have operated in the largest and most successful towns in England and in places where, so far as telephone requirements go, there should have been ample scope for full results. If a large commercial town like Halifax cannot number more than five-and-twenty subscribers, how then can it be supposed that the cities and towns in such comparatively unimportant counties as Norfolk, Suffolk, Glamorganshire, Radnorshire, Worcestershire, Gloucestershire, Somersetshire, Kent and Surrey give greater evidence of telephonic requirements and corresponding profits? It appears that by the agreement, the Globe Company will not get the shares in sub-companies, with some exceptions, if the territory is taken by other companies now negotiating for it. If this is so, why, of course, the value of its interest in the fusion is considerably minimised. We may point out that the sub-companies of the United Telephone Company have been in existence from three to five years, and, we believe, in *important* districts. If they have not paid any dividends, how can it be expected that these others will do so? Of course this is a vital question for the Globe Telephone Company, and touches the real value of its shares, as an investment.—EDS. ELEC. REV.]

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

THE half-yearly meeting of this company was held at the Cannon Street Hotel on Wednesday, Mr. John Pender, M.P., presiding over a large attendance of shareholders.

The Secretary having read the notice convening the meeting,

The Chairman, in submitting the report and balance sheet, stated that the gross receipts showed an increase of £23,943 over the corresponding period of the previous year; the working expenses showing an increase of £3,880. After quoting portions of the report, which we published last week, he said that negotiations successfully completed had resulted in the establishment for the French Government of a connection between Saigon, Annam and Tonquin, for which the company was to be paid £10,000 a year; and a connection between Macao and Hongkong, with a guarantee from the Portuguese Government of £500 a year. Unfortunately one of the cables had been interrupted, but, as he had frequently stated, an interruption which a few years ago would have put them in a great flurry, now caused them very little hesitation in dealing with their traffic. Now that commerce was depending so very largely upon the certainty of telegraphic communication, it was the duty of the company to endeavour to make its system as thoroughly efficient as possible; with this view, and having the interests of the shareholders in consideration, the board had carried out the principle of duplicating the system extensively; indeed, only one small cable was now without the application of the duplicate arrangement, and to this it was intended shortly to apply it. Connection with Foochow had been maintained with a great deal of difficulty, but the Chinese, seeing they were in earnest, and that they were honest, had agreed to give them a line from Foochow to connect with the cable there and at Sharp Peak; and they had also permitted the cable to be worked under English supervision. With regard to a reduction of tariff, this had been tried on the Australian traffic, but not with such a result as to encourage them to go on with it to any great extent. When they found there was likely to be a response to an extent that would recoup them for the reduction of the tariff they would only be too glad to accept lower rates. But he had learnt, in his commercial transactions, involving many thousands of pounds, that the question whether the rate was small or high for telegraphy did not enter into consideration; there were things for which telegraphy was necessary, and telegraphy must be used. When the duplicate Australian cables were laid it was arranged that Press telegrams should be carried at quarter rates. In five years the number only increased by 11 per cent., and the receipts showed a loss of 72 per cent.; this was a very conclusive argument. When the Atlantic cable companies reduced their tariff from 2s. to 1s., the increase of messages was only 22 per cent., and the loss was 37 per cent.; subsequently, when the 2s. rate was again enforced, the revenue increased 58 per cent. But he was prepared to say that when they saw any evidence on the part of the public that they were willing to increase the use of the telegraph they would only be too glad to meet it. With regard to the attempt in the newspapers to raise an agitation or a remonstrance against any alteration in the code systems at present in use, he must say that the merchants had all the best of the fight; their code books were got up so perfectly, that with a few words they could fill pages of paper. Their dividends would have been very different but for this perfect system of coding. But they were quite aware that the coding system was got up at a very large expense, and he could assure them there was no intention at the forthcoming conference of proposing any alteration. The Chairman concluded by moving the adoption of the report and balance sheet.

The Marquis of Tweeddale seconded.

Mr. Newton alluded to the correspondence in the daily papers as to the high charges to Australia, in which it was suggested that the Australian Government would lay a line. This, he said, was an extraordinary statement, for he understood that they had a contract of some sort with the colonies securing them a monopoly for a certain time, if they kept the communication intact. If this were so, the threat was altogether misleading, and raised ideas respecting the value of their property altogether erroneous. He thought, however, that the rate to Australia was too high, and he would like to see it lower. With regard to the compilation of codes, the very fact of their existence made their revenue a certainty, for telegraphic messages of a few words were made to express what would be otherwise conveyed by letter.

The Chairman said he would remind Mr. Newton that it was the companies who first suggested the use of codes, and he had said that if they had not been adopted they would not have cables enough to carry the traffic. But the merchants had done their coding so perfectly that they had, to a considerable extent, limited the dividend which they originally anticipated being able to pay. About a year ago, it would be remembered, a conference was held in Australia, at which the question of lower rates was discussed. This company then stated that it was earning such and such an income, and was paying such and such a dividend; the colonists might make the rate what they pleased if they would make up to the company the amount it was then earning. This was a fair challenge, but it was not accepted; they were prepared to repeat it, but it was their business not to reduce their rates in a manner which would lead to a reduction also of the dividend.

The motion was then put and carried, after which

Mr. Newton moved a vote of thanks to the chairman, and characterised the offer to the colonies a splendid one, removing all cause of complaint.

The vote having been heartily accorded, the meeting terminated.

The West India and Panama Telegraph Company, Limited.

THE following is the report of the directors of this company :—

The directors submit the accounts for the six months ending 30th June, 1884. The amount to credit of revenue is £50,677 5s. 10d., and the expenses have been £28,893 17s., leaving a balance of £21,783 8s. 10d., which, with the balance of £2,519 7s. 2d. brought from last account, makes a total of £24,302 16s. Of this sum the directors have placed £10,000 to reserve, leaving an available balance of £14,302 16s., with which it is proposed to deal as follows :—

Payment of 6s. per share on account of arrears of dividend on the first preference shares...	£10,368	18
Balance to current half-year's account ...	3,933	18
	£14,302	16

The traffic receipts show a decrease of £3,059 9s. 4d. on those of the corresponding period of 1883, which is partly attributable to the depression in the sugar market and the interruption of the Demerara cable referred to in the last report. It must, however, be remembered that the returns for 1883 were augmented by the exceptional traffic during an interruption of the Central and South American Company's cables, which compete with this company's system at the Isthmus of Panama. On the other hand, the revenue for this half-year has benefited by the chartering of the company's ss. *Grappler* to the International Ocean Telegraph Company for the repair of their Havana-Key West cables.

Satisfactory progress has been made towards the restoration of the original Jamaica-Porto Rico cable, the repairs of which have now been completed from San-Juan (Porto Rico) to within 30 miles of Jamaica.

The *Grappler* is now at work at the Jamaica end, and it is expected that the re-establishment of this important duplicate cable will be shortly reported. This operation, which will add materially to the security of the communications with the whole of the West Indian colonies eastward of Jamaica, has, owing to the great depth of water and the nature of the sea bottom, been both tedious and costly. It is hoped that this effort of the company to maintain and fortify the Colonial connections to an extent far in excess of that contemplated by the single line system, which formed the basis of the original contract with the Colonies, will be recognised by both Imperial and Colonial Governments, and by the interests associated with West Indian possessions, whether British or foreign.

The appeals to the Colonies for some revision of the unfortunate arrangements entered into at the formation of the company have resulted since the last meeting in an increase of the Grenada subsidy, from £500 to £1,000 per annum, and of the St. Lucia subsidy from £500 to £800 per annum, both to commence on 1st January, 1885. These additions to the company's resources deserve the most grateful acknowledgment to the Colonies which have granted them, and give a much needed encouragement to the company's endeavours to maintain the telegraphic system of the region.

The Colony of St. Vincent declines at present to augment its subsidy on the ground of the depressed condition of the sugar trade. The situation in Barbadoes and the Leeward Islands remains unchanged.

The terms for which the foreign colonies, Guadeloupe, Martinique and St. Thomas granted their subsidies expire on the 31st December next, and applications have been made to them for renewals.

The severe crisis through which the commerce of the West Indian Colonies is now passing, causes much anxiety to the directors, although the traffic receipts of the current half-year have not as yet been impaired.

Several interruptions to the cables occurred during the half-year under report, which were repaired with every possible despatch.

The Telephone Company of Ireland, Limited.

THE directors' report for the six months ending the 30th of June, 1884, is as follows :—The number of subscribers to the exchange system of the Dublin district, and also of the renters of private lines, as compared with the corresponding period last year, and also with the 31st December, 1883, is as follows :—

DATE.	No. of Exchange Subscribers.	No. of Renters of Private Lines.	Total.
30th June, 1883...	411	127	538
31st December, 1883	507	140	647
30th June, 1884...	568	168	736

As the shareholders are aware, the business of the company has hitherto been limited, under the Post Office licence, to the Dublin district only, within a radius of five miles from the central Post Office. The Postmaster-General has, however, now agreed to grant licences without limit as to radius, and the directors will thus be enabled to extend the operations of the company within their territory wherever they find the business can be made remunerative.

The new licence will permit the company to open public call-offices, and also to give intercommunication between towns. The directors anticipate that these privileges and conveniences will tend greatly to facilitate business and be of considerable advantage to the company.

That the telephone supplies a want not met by the telegraph, namely, that of obtaining an instantaneous reply, is demonstrated by the fact that the gross rental of the company from the Dublin district alone is now already upwards of £8,000 per annum over an area with a radius of five miles from the central Post Office, whilst the amount received by the Post Office Department from telegrams despatched from an area with a radius of twelve miles from the Post Office to addresses within the same area, as stated by the Postmaster-General in the House of Commons on the 9th June, 1884, was only £1,390 per annum.

The line to Kingstown is now practically complete, and will be opened to the public so soon as the new licence from the Post Office has been perfected. The board have to thank the directors of the Dublin, Wicklow, and Wrexford Railway Company for the liberal spirit in which they have granted the necessary way-leave for poles to carry this line along and across a portion of their railway.

With a view to provide sufficient funds for the development of the business, without using the uncalled capital, and for the reasons already explained to the shareholders, the directors have considered it advisable to place a further portion of the unallotted shares. This they have done (after first offering said shares to the shareholders) to an extent sufficient for the present purposes of the company without the necessity of any appeal to the public. These shares were offered as Six per cent. shares, which the directors propose to exchange into Five per cent. shares, at the rate of 120 Five per cent. for 100 Six per cent., in accordance with the terms of the issue.

Subject to the approval of the shareholders, the £2,258, being 10s. per share credited as paid on the 4,516 Five per cent. shares issued during the half-year ended 30th June, 1884, on conversion of the Six per cent. shares into Five per cent. shares, in accordance with the special resolution of the 7th September, 1883, has been written off to expenditure on capital account, and the directors propose to write off in like manner such further sum as may be credited in connection with the exchange of any Six per cent. into Five per cent. shares of the authorised issue of £50,000.

Since the date of the last half-yearly meeting, still further progress has been made in the conversion of the 25,000 old Six per cent. shares. At date of last report 3,720 shares remained unconverted. This number had been reduced on 30th June last to 2,405, and the directors propose, subject to the approval of the shareholders, to redeem and extinguish the small balance of these shares now remaining, upon the following terms:—To exchange the Six per cent. shares 10s. paid, for Five per cent. shares fully paid, at the rate of five Six per cent. shares 10s. paid for three Five per cent. shares fully paid, or upon such other terms as may be agreed upon, or as in the opinion of the directors may be most beneficial in the interests of the company.

The amount standing to the credit of profit and loss, including the balance of £259 15s. 4d. brought forward from last account, amounts to £1,362 10s. 7d. This admits of payment to the preference shareholders of the full dividend, amounting to £388 0s. 4d. upon the preference shares; also of a dividend at the rate of one per cent per annum, upon the ordinary shares, amounting to £875, as against nil for the corresponding half-year ended 30th June, 1883; and of one-half per cent. for the last half-year, ended 31st December, 1883; leaving a balance of £99 10s. 3d. to be carried forward to the credit of the current half-year.

The Indo-European Telegraph Company, Limited.—The directors have declared an interim divided for the half-year ending the 30th June last, at the rate of 5 per cent. per annum, free of income-tax, payable on and after the 1st of November next.

The Globe Telegraph and Trust Company, Limited.—An interim divided of 3s. per share on the preference shares, and 2s. per share on the ordinary shares, for the quarter ending the 18th inst. is announced, payable on and after the 24th inst.

British Spiral Telephone Wire Syndicate, Limited.—A petition for the winding-up of this company is to be heard before Mr. Justice Chitty on the 25th inst.

The Electric News Telegraph Company, Limited.—A special meeting of this company was held on September 23rd, when it was resolved to wind up voluntarily.

Hygienic Electric Association, Limited.—Creditors are required to send particulars of their claims to the liquidator by the 15th of November.

TRAFFIC RECEIPTS.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending September 30th were £3,465.

CORRESPONDENCE.

The "Mechanic" Receiver.

Graham Bell's disclaimer is dated 24th January, 1878, and is numbered 4,765*. It can be procured at the Patent Office, 38, Cursitor Street, Chancery Lane, E.C., price 6d. This document, after stating that some of the claims in the patent were not new by reason of descriptions having been published in England before the date of the patent, 9th December, 1876, proceeds to state that he confines his claims to arrangements of telephonic apparatus wherein are employed plate armatures or armatures other than those carried by a membrane, and arrangements wherein are employed permanent magnets, or magnets excited by batteries which are not in the main circuit or line wire. This patent was contested and held good by Fry, J., and the Court of Appeal in the case of the United Telephone Company *v.* Harrison, Cox-Walker. It therefore follows from disclaimer that the only telephones which are protected are those using permanent magnets and plate armatures. The patent for transmitters was upset in the above case. For a full description of various telephones see Hospitalier on the Telephone, price 12s. 6d., and Moncel on the Telephone, 5s., both published by Kegan Paul & Co.

Stat nommis umbra.

With respect to the letter of Mr. W. C. Barney in your last issue, I should like to mention that I, like him, have not got *Engineering* for September, 1876, before me. I have, however, in my possession a letter from the Editor of that paper, which affirms that though they had had the drawings and description in their keeping for several months previously, owing to an accident their first notice and description of Bell's original instrument was not published till December 22nd, 1876.

I have to thank Mr. T. J. Handford for his information respecting Morgan Brown's disclaimer, and should be glad if he, Mr. Barney, or any other correspondent, can give any definite information as to the state of the case between the United and the Globe Telephone Companies, and the bearing of their relations upon the "Mechanic" Receiver patents, for improvements in which were the property of the latter company. Perhaps some one could give the numbers of these patents.

I hope at some future time to have something to say with reference to Mr. F. G. Olliver's letter in your issue for September 20th, as some facts have recently come to my knowledge which throw an important light upon some somewhat remarkable transactions on the part of the United Telephone Company with reference to the sale, in this country, of instruments infringing its patents. But of this, with the Editor's permission, more anon.

S.

The Breakage of Atlantic Cables.

We notice in your issue of the 11th October a paragraph referring to the *Faraday*, and containing suppositions as to the cause of the recent breakages of Atlantic cables, which are not borne out by facts.

The fractures of the three Atlantic cables in question took place on the eastern side of the Great Bank of Newfoundland, during the night, from 3rd to 4th instant. At that time the *Faraday* was at the western side of the same bank, more than 100 miles westwards from the locality of the fractures. Besides, the *Faraday* since her departure from England, up to the present, has not been engaged in any operation of grappling, nor did she anchor until the 9th instant, when she arrived at Dover Bay, Nova Scotia.

Siemens Bros. & Co., Limited.
L. Loeffler, *Managing Director.*

12, Queen Ann's Gate, Westminster.
London, *October* 14*th*, 1884.

Electrical Energy Recorder.

Whilst bowing to the superior knowledge of your correspondent, Mr. Fred. Walker, I can hardly admit that I have run into print "with but a vague idea of what I am writing about." Mr. Fred. Walker's energy recorder, as I understand it from the drawing and description in your esteemed paper, was simply a solenoid with a lever carrying a pencil at the end of it, or pen, as the case might be, the action of the current upon the core tending to raise the pencil point from zero upwards, in proportion to the amount of current passing. This was precisely the same kind of instrument that I used in the winter of 1882; and as I said before, I also made the same thing in the summer of 1883, only substituting a fine wire coil for the coarse one, for showing the variation of potential.

Will Mr. Fred. Walker deign to throw a little of the brightness of his intellect on to what seems to me, in my ignorance, to be a plain subject, and tell me wherein these two instruments that I made separately differ from the one that he made, which he places upon one board recording on one drum, instead of using two separately as I did? I am not well up in the patent laws of this country; but I am under the impression (always open to correction) that the fact of my having made and used these instruments would negative Mr. Walker's patent.

Were I a great and shining light, or did I wish to be considered so, I would have great pleasure in removing Mr. Walker's objection to my writing under a *nom de plume*; but as I am only a student of a great science, I must again sign myself an humble follower in the footsteps of

"Volta."

October 15*th*, 1884.

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